SOVIET INDUSTRY

TRENDS IN OUTPUT, INPUTS, AND PRODUCTIVITY

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Output, Input, and Productivity Trends in Soviet Industry

I. Introduction

A. Slowdown in Soviet Industrial Growth

Despite the declining trend evident since 1955, Soviet industrial output almost quadrupled during 1951-65 for an average annual rate of growth of 9.3 percent. This impressively high rate, equaling or surpassing those of the most rapidly growing economies of the Atlantic Alliance -- Germany and Italy -- reflects the importance assigned to rapid industrial development by the Soviet leadership. Almost 40 percent of the new investment since 1950 have been directed to renewing and expanding industrial capacity -- the highest share of investments used for this purpose in any modern industrial nation. Industry's priority claim on the annual increments of trained manpower in the USSR is exceeded only by the direct needs of the defense-space establishment. Thus the high rate of growth observed in Soviet industry can be explained, in large part, by the continued commitment of large doses of economic resources -- capital investment and labor. But this is not the whole story.

In the USSR, as in all countries, the magnitude of economic growth depends on more than changes in the number of workers, the number of hours worked, and the services of tangible capital. To a large extent, rapid growth in the USSR has resulted from high rates of increase in the efficiency with which labor and capital resources have been employed. One measure of this efficiency is an index of output per unit of capital and labor combined -- that is, per unit of

"inputs." In the US, for example, in the first half of this century it has been estimated that one-half of the growth in national output can be accounted for by growth in inputs and the rest by growth in the ratio of output per unit of inputs. 1/

Both official Soviet data and Western estimates show a marked decline in the rate of growth of industrial production in the USSR in recent years. The agenda for economic reform in industry outlined by Premier Kosygin in September 1965 demonstrates that the Soviet leadership is not satisfied with the current performance of industry. This paper carries forward, with some modifications, estimates of industrial production which appeared in "Dimensions of Soviet Economic Power," a publication sponsored by the Joint Economic Committee four years ago. 2/ These new estimates indicate that a slowdown in growth has indeed occurred in industry as a whole and in most branches of industry. After presenting these estimates of industrial production, this paper then examines the performance of Soviet industry since 1950 from the point of view of two basic elements of industrial growth: (1) the change in inputs of capital and labor and (2) the change in efficiency of resource use or factor productivity. The calculations of factor productivity presented in this paper are at best tentative estimates of the change in the ratio of outputs to inputs. Alternative calculations of factor productivity based on different schemes for weighting labor and capital inputs, however, do not affect materially the findings regarding the importance of a decline in the growth of factor productivity in explaining the deterioration in industrial performance. 3/

Some of the more important reasons for increases in factor

productivity are (1) improvement in production techniques and in technology in general, (2) economies of scale of operation that result from specialization and division of labor as the economy or any particular branch of the economy expands, (3) a more efficient or better trained supply of labor that results from higher levels of education and skills and gradually improved health, (4) improved quality of plant and equipment to the extent it is not covered by the imperfect measures of the growth in capital services, (5) better administration and management of the economy from the highest managerial levels down to the enterprise director and shop foreman, and (6) improved quality and supply of raw materials used by industry.

The concluding section of this paper tries to uncover some of the more important causes of the slippage in productivity growth in Soviet industry. Variations in the relation of output to inputs in particular sectors at particular points of time suggest the possible effect of changes in Soviet policies with respect to industrial administration, the introduction of new technology, labor incentives, and the like. Finally, the output and productivity goals of the 1966-70 plan for industry are appraised in the light of past performance.

B. Methods Used in Estimating Output, Inputs, and Factor Productivity in Industry.

1. Indexes of Output

The index of production used in this report is an adaptation of an index published by CIA in 1963 4/ Therefore it is a weighted index of the indexes calculated for output in each industrial branch. The various branch indexes are aggregated with value-added weights and the individual branch indexes

represent a summation of the value of sample commodities in 1 July 1955 prices. However, the index used here differs in some important respects from the CIA index: 1.) it revises some of the commodity series and extends all of them to incorporate data in the latest Soviet statistical handbooks, 2.) some of the branch of industry samples are expanded to include more items or to disaggregate sample items into components that better reflect changes in the production mix, 3.) it substitutes 1960 value-added weights with an explicit capital charge for the 1955 weights used in the CIA index, and 4.) the index for the machine building and metal working (MBMW) is an adjustment of the official Soviet gross value of output (GVO) indexes rather than an index based on a sample of civilian machinery items; therefore it includes both civilian and military production.

Because of these differences, the industrial production index presented in this paper rises more rapidly than the CIA index -- by 10.0 percent per year during 1951-61 compared to 9.3 percent for the CIA index. 5/ Three of the sectors most affected are ferrous metals, forest products, and MBMW. The ferrous metals index used in this report incorporated new data on the composition of Soviet steel output as reported in the United Nations Quarterly Bulletin of Steel Statistics as well as the increasingly important production of foundry pig iron, rolled stock for reprocessing, and exports of iron ore and pig iron. In contrast to the CIA index, the index for forest products used in this paper includes a series for production of furniture. The major difference between the index of industrial production presented here and that estimated by CIA, however, derives from the use in this paper of a modified version of the official Soviet GVO index for MBMW instead of a calculated index for civilian

machinery. There is no Western estimate available that claims to represent both the civilian and the military components of MBMW. Because the data on inputs in MBMW relate to total outputs, not merely to civilian output, the index of output used in charting productivity trends also had to represent total output. The index was derived in a somewhat round-about manner as follows.

First of all, it is assumed that the official GVO index for MBMW overstates growth ~~in the same way~~ for the same reasons that Western students have concluded that GVO indexes exaggerate growth in ~~other branches of industry~~ general. The question is, by how much? According to the estimates made in this paper, the ratios of average annual "actual" growth to average annual growth in GVO in the separate branches of Soviet industry during 1951-64 fall within a fairly narrow range. The ratio of "actual"(estimated) growth to growth in GVO is highest for ferrous metals (.95) and lowest for chemicals (.78). The ratios for all branches except ferrous metals and chemicals range between .87 and .92 (excluding the nonferrous and fuels branches, for which comparisons are not possible.) ~~It is true that~~ However, most of the reasons for believing that GVO indexes overstate growth apply with particular force to ~~the~~ MBMW -- for example, the likelihood of growing specialization and the high rate of introduction of new products into the index on a dubious price basis. Therefore, the proper discount of GVO growth in MBMW might be closer to that for chemicals than to the average for all sectors. For this paper three separate indexes of MBMW (and of industrial) output were calculated based on the alternative assumptions that for any given year the ratio of actual percentage growth in MBMW to the percentage growth in MBMW GVO was

.9, ~~.8~~, ~~or~~ .8 and .7. The indexes of output and factor productivity presented below are based for the most part on the MBMW and industrial production indexes that incorporate the second of the above alternatives -- a 20 percent discount of the growth in GVO reported by the Soviets. Although it is not claimed that this particular alternative is a reliable barometer of the precise extent of the growth of civilian and military machinery since 1950, it seems suitable for the purposes of this paper. The average annual growth in industrial production during 1951-65 is 9.3 percent under the assumption of a 20 percent discount of officially reported GVO growth in MBMW, while ~~assuming~~ discounts of 10 percent and 30 percent result in average annual increases of and 9.7 and 8.9 percent. This range is not large enough to make a material difference for the findings of this paper with respect to trends in output and productivity.

2. Indexes of Inputs and Factor Productivity

Factor productivity for industry and nine industrial branches is calculated by dividing the indexes of output described above by indexes of labor inputs and capital stock combined.[6] ~~The indexes of capital stock are derived with a few adjustments from official Soviet indexes.[5]~~

The capital stock indexes are derived with a few adjustments from official Soviet indexes. The indexes represent gross (undepreciated) reproducible fixed productive capital stock. They include structures and equipment and exclude land and other natural resources (except in the sense of mine shafts and diggings) and inventories. These assets are valued at replacement cost in what are basically 1955 prices rather than at original cost, and hence the index is a "constant price" index. The labor input is measured in two ways -- by the number of workers employed and by the number of man-hours worked. These two measures differ significantly because hours worked per day and number of workdays per year have declined in the USSR since 1955. Alternative combined input indexes using both employment and man-hours were calculated.

In US practice, labor and capital inputs are combined into one index by the use of the share of income earned by each input as its weight. Data on wages of labor in Soviet industry are available, but there is no explicit accounting of a return on capital in the USSR. In order to construct possible weights for capital inputs, two alternative interest returns were assumed -- 8 percent and 13 percent -- and were combined with amortization allowances to ~~approximate~~ simulate gross return on capital.[7]

system of weighting capital and labor inputs is clearly arbitrary, and different assumptions give different results. Alternative weights and indexes were calculated to illustrate the range of possible results. The alternative indexes use in turn (1) interest rates of 8 percent and 13 percent, and (2) 1950 and 1960 base years for the calculation of weights. A basic geometric or Cobb-Douglas formula was used to combine the capital or labor inputs.* One index of labor and capital inputs combined was selected for the primary presentation in the following section -- a geometric index based on 1960 weights and an interest rate of 8 percent. For this particular index the base-period weights of capital and labor are intermediate in the range of alternatives. The other, alternative, indexes, however, also are considered in the analysis of the results.

Input and factor productivity indexes have been calculated for nine branches of Soviet industry as well as for industry as a whole. These nine branches do not ~~exhaust~~ cover all of industry -- electric power and nonferrous metals and some small miscellaneous categories are missing. Because of this and because of questions regarding the comparability of the branch labor and capital inputs with each other and with output, the individual branch indexes are less reliable than those for all of industry.

C. Limitations on the Meaning of the Results

The nature of the data and the calculations places severe limitations on the use of the results. The rate of growth in factor productivity depends on arbitrary assumptions as to the interest return on capital. For this

* See Appendix A for the derivation of the index formula used in calculating factor productivity.

reason alone, a direct comparison with similar calculations for US industry is of limited value. Moreover, capital stock measurements in the USSR and the US are not comparable, and even the calculations of industrial output indexes are not as similar in their procedures as one would wish.

Comparisons of factor productivity between branches of Soviet industry may be attempted in a general way, but a precise analysis of the differences among the branches is hindered by the uncertainties of the data and especially by the assumption that the interest return on capital is the same in all branches.

The data on inputs and outputs, however, are considered to be reasonably consistent through time. Therefore, changes in trends in productivity for all industry and for the branches of industry are believed to be meaningful. In particular the slowdown in Soviet industrial growth in recent years appears to be indisputable, and one finding of this paper -- that a decline in the growth of factor productivity contributed significantly to the slowdown -- also appears to be indisputable. It is noteworthy that Soviet official data support these two conclusions unequivocally and that Premier Kosygin in his speech on the new five-year plan in April 1966 underscored the need to restore rates of growth in labor productivity.

II. Growth of Industrial Output, Inputs, and Factor Productivity, 1951-65

A. Industry as a Whole

1. Trends in Output, Combined Inputs, and Factor Productivity

From 1950 to 1965 the USSR achieved rapid industrial growth, but since 1955 this growth has tapered off. The increase in industrial

output averaged about 11 percent annually during 1951-55, 9½ percent during 1956-58, 8½ percent during 1959-61, and little more than 7 percent during 1962-65.[8] The index of industrial production and its components are shown in Table 1.*

* Page 9a, below.

Of the three major sectors of industry, machine building and metalworking had the highest rate of growth during 1951-65, and the vigor of its expansion has held up best. The average annual growth in output of industrial materials and consumer nondurable goods was about the same in 1951-55; thereafter, growth in consumer nondurable goods slumped much more seriously than that of industrial materials.

Average Annual Rate of Growth in Output

(Percent)

	1951-65	1951-55	1956-58	1959-61	1962-65
Industrial materials	8.8	10.6	9.5	7.8	7.0
Machine building and metalworking	11.9	13.7	10.9	12.0	10.1
Consumer nondurable goods	7.1	9.9	7.4	5.7	3.5
Total industry	9.3	11.2	9.5	8.6	7.3

Between 1950 and 1965, Soviet industrial output increased by 279 percent while inputs of capital and labor combined increased by 106 percent. Thus, if growth had been based only on use of additional inputs, it would have been only a little more than half of the average annual growth actually attained. In other words, without an increase in resource productivity, industrial output would have advanced at an average annual rate of 4.9 percent instead of the actually observed growth of 9.3 percent. The balance of total industrial growth was associated with increases in factor productivity -- averaging 4.2 percent annually for the entire period. But this advance in the rate of growth in factor productivity (shown in Table 2*) has been far from steady -- accelerating through most of 1951-58, dropping

* Page 10a, below.

Table 1

USSR: Indexes of Industrial Production, 1950-64a/

	1960 Value b/ Added Weights	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
Industrial materials	50.25	~~39.1~~ ~~39.9~~	~~44.2~~ ~~45.2~~	~~49.2~~	~~53.0~~	~~59.1~~ ~~59.0~~	~~64.7~~ ~~65.5~~	~~70.5~~ ~~71.3~~	~~77.2~~ ~~77.9~~	~~85.0~~ ~~85.5~~	~~93.6~~ ~~94.0~~	~~100.0~~ 100.0	~~106.5~~ ~~106.1~~	~~113.8~~ ~~113.1~~	~~121.4~~ ~~120.4~~	~~131.1~~ ~~128.7~~	137.5
Electric power	4.27	31.4	35.8	41.0	46.2	51.7	58.2	65.6	71.9	80.7	90.7	100.0	112.1	126.5	140.7	156.4	172.5
Coal	10.85	50.1	54.3	57.8	61.1	66.5	75.0	82.2	88.6	95.1	97.8	100.0	100.0	102.0	105.0	109.2	113.6
Petroleum products and natural gas	3.37	27.2	30.3	33.9	37.9	42.7	47.5	56.6	66.6	76.7	87.8	100.0	112.3	127.4	141.6	155.1	169.0
Ferrous metals	7.37	38.8	44.6	50.2	55.6	61.3	68.0	73.7	78.1	83.9	91.9	100.0	108.1	116.8	124.1	134.0	146.1
Nonferrous metals	3.60	36.8	43.0	51.4	56.5	62.7	70.8	76.0	79.8	83.3	94.0	100.0	114.9	120.9	130.9	138.4	150.0
Forest products	9.31	~~55.2~~ 50.8	~~63.5~~ 58.1	~~64.4~~ 59.3	~~65.5~~ 61.1	~~74.0~~ 69.0	~~77.1~~ 72.8	~~79.8~~ 75.4	~~85.1~~ 81.3	~~91.8~~ 87.1	~~100.8~~ 99.0	100.0	~~99.4~~ 101.3	~~101.5~~ 105.3	~~105.6~~ 111.2	~~108.9~~ 116.4	119.2
Paper products	.85	45.6	51.1	56.5	63.8	70.1	73.3	79.0	85.8	91.6	95.7	100.0	105.9	113.4	119.7	128.6	145.5
Construction materials	6.53	~~20.5~~	24.1	27.8	31.7	36.8	44.0	50.3	60.5	72.6	86.7	100.0	110.5	120.4	127.2	135.7	146.2
Chemicals	4.10	31.6	37.0	41.4	46.1	51.5	59.3	65.1	72.9	82.0	91.6	100.0	107.9	117.6	129.4	145.4	162.2
Machine building and metal working	30.38																
GVO growth discounted by 10 percent		26.8	31.2	35.7	40.8	46.9	54.8	61.8	69.1	77.6	88.3	100.0	113.5	129.1	144.4	156.6	169.5
GVO growth discounted by 20 percent		30.8	35.2	39.8	44.9	50.8	58.4	65.0	71.8	79.7	89.4	100.0	112.0	125.7	138.9	149.3	160.3
GVO growth discounted by 30 percent		35.4	39.9	44.4	49.4	55.0	62.3	68.5	74.8	81.9	90.6	100.0	110.5	122.3	133.6	142.4	151.5
Consumer nondurable goods	19.37	45.0	52.8	56.1	62.0	67.5	72.0	77.8	83.1	89.3	96.1	100.0	105.3	110.3	111.6	116.7	124.7
Light industry	11.24	44.4	53.1	55.7	60.9	67.9	72.0	76.7	81.8	88.5	94.5	100.0	103.2	107.5	109.8	114.4	116.9
Food industry	8.13	45.8	52.4	56.7	63.5	67.0	72.1	79.4	84.9	90.3	98.2	100.0	108.1	114.1	114.2	119.8	135.5
Aggregate industrial production	100.00																
With MBMW GVO growth:																	
Discounted by 10 percent		~~36.9~~ 36.5	~~42.4~~ 41.9	~~46.4~~ 45.9	~~51.0~~ 50.4	~~57.0~~ 56.5	~~63.5~~ 63.1	~~69.7~~ 69.3	~~76.2~~ 75.9	~~83.8~~ 83.6	~~92.6~~ 92.5	100.0	~~108.2~~ 108.4	~~117.4~~ 117.8	~~126.1~~ 126.5	~~134.8~~ 135.5	145.7
Discounted by 20 percent		~~38.1~~ 37.7	~~43.6~~ 43.1	~~47.7~~ 47.2	~~52.3~~ 51.9	~~58.1~~ 57.7	~~64.6~~ 64.2	~~70.7~~ 70.3	~~77.1~~ 76.7	~~84.5~~ 84.2	~~93.0~~ 92.8	100.0	~~107.7~~ 107.9	~~116.4~~ 116.7	~~124.3~~ 124.0	~~132.6~~ 133.3	142.9
Discounted by 30 percent		~~39.5~~ 41.1	~~45.1~~ 44.6	~~49.1~~ 48.6	~~53.6~~ 53.2	~~59.4~~ 59.1	~~65.8~~ 65.4	~~71.9~~ 71.3	~~78.0~~ 77.6	~~85.1~~ 84.9	~~93.3~~ 93.2	100.0	~~107.3~~ 107.5	~~115.3~~ 115.7	~~122.7~~ 123.2	~~130.5~~ 131.2	140.3
Official Soviet index of the gross value of industrial production c/		33.0	38.5	42.9	48.0	54.4	61.1	67.6	74.4	82.1	91.4	100.0	109.2	119.7	129.4	138.9	150.8

a. The branch indexes of industrial production, except for MBMW, are indexes of the gross value of the CIA sample, as described in the text. The MBMW (and the aggregate industrial production) index is presented in three variants for the reasons discussed in the text.

b. The weights, except for electric power and nonferrous metals, are derived from the labor and capital weights shown in Appendix A, Table 6, p. 48. An 8 percent interest rate was applied to capital stock. The weights for electric power and nonferrous metals were estimated separately. Average annual capital stock and the amortization rate for capital stock for these branches are based on the same sources used for the other branches in Table 6. Average annual employment of industrial production personnel in 1960 is estimated at 464 thousand for nonferrous metals and 411 thousand for electric power. Average annual earnings in nonferrous metals is estimated at 1700 rubles and at 1020 rubles in electric power. For employment, see Vladimir G. Treml "Economic Interrelations in the Soviet Union", Annual Economic Indicators for the U.S.S.R., Joint Economic Committee, Washington, 1964, p. 203, and Gertrude Schroeder, "Soviet Industrial Labor Productivity", Dimensions of Soviet Economic Power, Joint Economic Committee, Washington, 1962, p. 162. The estimates of average annual earnings are based on the same sources that were used to estimate average annual earnings for the other branches of industry in Table 6.

c. USSR, Central Statistical Administration; "Narodnoye khozyaystvo SSSR v 1964 godu," Moscow, 1965, p. 124, ~~SSSR v tsifrakh v 1965 godu~~, Moscow, 1966, p. 54.

slightly in 1959-61, and then declining abruptly in 1962-65. These trends in factor productivity reflect the trends in output and in the combined inputs of capital and labor.^ (Figure 1) The growth in output fell between .7 and 1.8 percentage points in each of the subperiods 1956-58, 1959-61, and ~~1962-65~~ 1962-63 and 1964-65. The index of inputs increased at 6.4 percent per year during 1951-55; then the rate of increase declined to 3.6 percent per year during 1956-58 and to 3.0 percent per year during 1959-61. Following the completion of the reduction in the length of the workweek, the growth in inputs of labor and capital rebounded to ~~5.6~~ 5.3 and 5.8 percent during ~~1962-65~~ 1962-63 and 1964-65. Meanwhile the growth in factor productivity climbed from an annual rate of 4.5 percent during 1951-55 to 5.7 percent in 1956-58. The rate of increase in factor productivity sagged slightly in 1959-61 to 5.4 percent and then precipitously to ~~1.6~~ 2.2 and 1.1 percent in ~~1962-65~~ 1962-63 and 1964-65. The most rapid growth in factor productivity (5.7 percent and 5.4 percent) occurred during 1956-58 and 1959-61 as the rate of growth in inputs continued to decline. In 1962-65, however, there was a further slowdown in the growth of output in the face of a sharp increase in the rate of growth of inputs. Consequently the growth in factor productivity fell to the lowest annual rate of the whole period.

The trends in inputs and factor productivity suggest that a pronounced change occurred during 1962-65 in the causes of the slowdown in the growth of industrial output. Through 1961, successive declines in the rate of growth in inputs account for the slowdown in output. After 1961 the slower growth in factor productivity is dominant.

** Following p. 10a.

Table 2

USSR: Output, Input, and Factor Productivity Trends in Industry, 1950-64 65

Estimated Indexes (1950 = 100)

	1953	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
Index of output a/	137.5 ~~137.1~~	170.3 ~~169.5~~	186.4 ~~185.4~~	203.5 ~~202.3~~	223.4 ~~221.6~~	246.2 ~~244.0~~	265.2 ~~262.4~~	286.2 ~~282.7~~	309.6 ~~305.4~~	331.1 ~~362.2~~	353.6 ~~348.0~~	379.2
Index of capital stock b/	137.1	170.6	191.0	211.7	235.6	262.2	292.4	327.0	362.0	403.4	447.4	491.0
Indexes of labor services c/												
Adjusted employment	117.1	126.5	130.6	133.7	139.2	144.0	151.1	159.1	164.2	168.9	174.4	181.9
Man-hours per worker	99.3	98.9	96.0	94.1	91.8	89.4	84.8	80.1	79.9	80.2	80.8	NA
Total man-hours worked	116.3	125.1	125.4	125.8	127.8	128.7	128.1	127.4	131.2	135.5	140.9	147.0 e/
Indexes of inputs d/												
Capital and man-hours	121.8	136.5	141.1	145.5	151.7	157.1	161.4	165.9	174.3	183.9	194.7	206.0
Capital and employment	122.4	137.5	144.3	152.1	161.3	170.3	181.8	194.7	204.9	215.5	227.0	240.2
Indexes of factor productivity d/	9	8	132.1	140.0	147.3	156.7	164.3	172.5	177.6	180.0	181.6	
Man-hours	112.6	124.2 ~~131.4~~	~~139.0~~	~~146.1~~	~~155.4~~	~~162.6~~	~~170.5~~	~~175.2~~	~~177.4~~	~~178.9~~	184.1	
Employment	~~112.1~~ 112.3	~~123.3~~ 123.9	~~127.6~~ 128.3	~~133.0~~ 133.8	~~137.4~~ 138.5	~~143.3~~ 144.6	~~144.4~~ 145.9	~~145.2~~ 147.0	~~149.0~~ 151.1	~~151.4~~ 153.6	~~153.3~~ 155.8	157.9

Average Annual Rates of Growth (Percent)

	1951-64 5	1951-55			1956-61			1962-64 5	
		1951-55	1951-53	1954-55	1956-61	1956-58	1959-61	1962-63	1964-65
Output	9.3 ✓	11.2 ~~11.1~~	11.2 ~~11.1~~	11.3 ~~11.2~~	9.0 ~~8.9~~	9.5 ~~9.4~~	8.6 ~~8.5~~	7.6 ~~7.2~~	7.0
Inputs								5.3 ~~5.2~~	
Capital and man-hours	4.9 ✓	6.4	6.8	5.9	3.3	3.6	3.0		5.8
Capital and employment	6.0 ✓	6.6	7.0	6.0	6.0	5.5	6.5	5.2	5.6
Factor productivity		4.5 ~~4.4~~	4.1 ~~4.0~~	5.1 ~~5.0~~	5.5 ~~5.4~~	5.7 ~~5.6~~	5.4 ~~5.3~~	2.2 ~~1.6~~ e	1.1
Capital and man-hours	4.2 ✓								
Capital and employment	3.1 ✓	~~4.3~~ 4.4	3.9	~~4.9~~ 5.0	2.8 2.9	3.7 3.8	~~1.9~~ 2.0	~~1.8~~ ✓ 2.2	1.4

Footnotes to Table 2

a. The variant incorporating a 20 percent discount of the growth in MBMW GVO, Table 1, p .

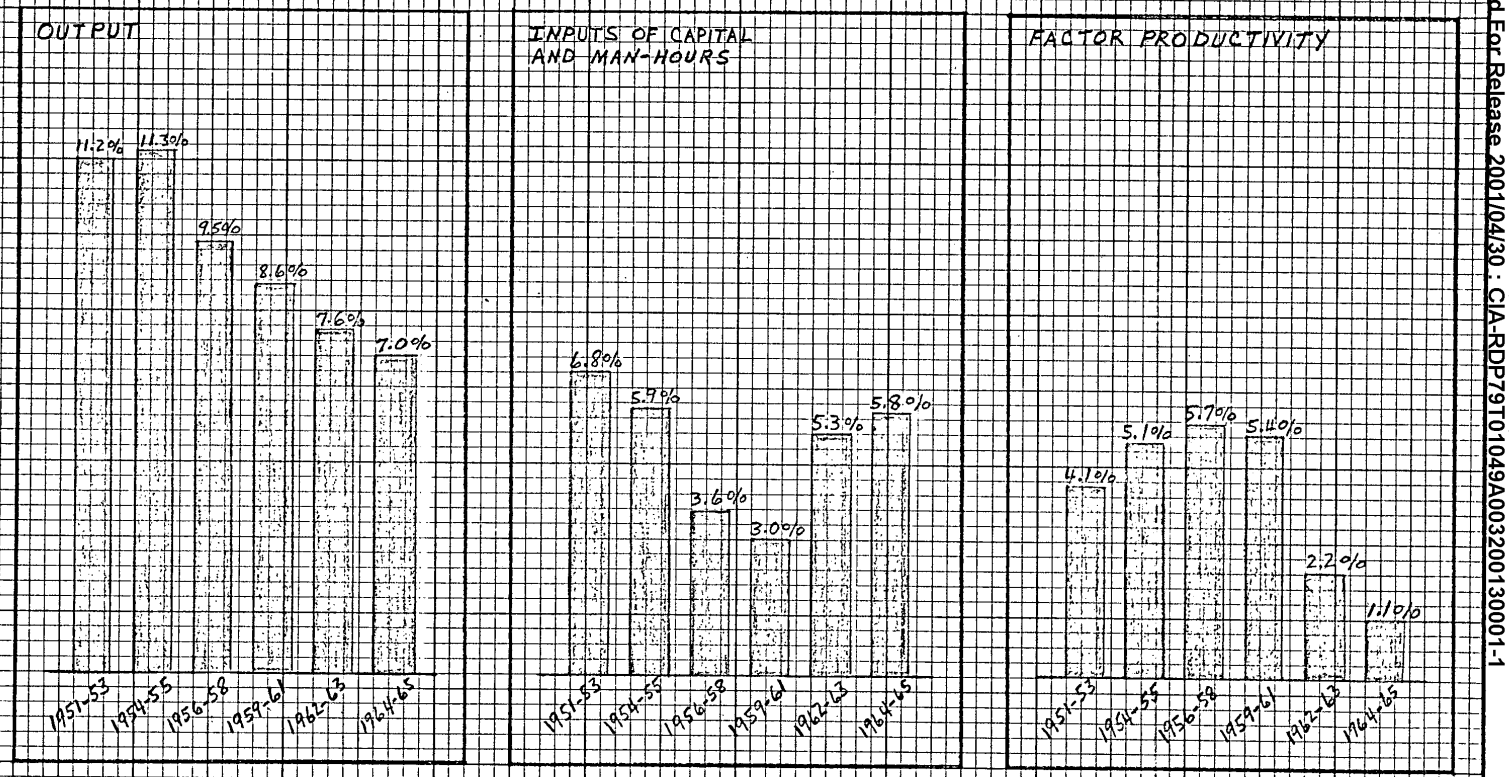
b. From Table 8 , p50a .

c. From Table 7 , p42a .

d. From Table 9 , p 54 . The index of inputs is a weighted index of labor inputs (measured in man-hours or employment) and capital stock (at an interest rate of 8 percent). The inputs are combined using 1960 base-year weights in a geometric function (see Appendix A).

e. Assuming no change in man-hours worked per year by the average industrial worker.

FIGURE 1.



USSR: ESTIMATED AVERAGE ANNUAL RATES OF INDUSTRIAL GROWTH: OUTPUT, INPUTS OF CAPITAL AND MAN-HOURS, AND FACTOR PRODUCTIVITY, 1951-65

Although the growth of total inputs into industry varied considerably during 1951-65, the growth of capital services as represented by productive capital stock did not.* Capital stock increased rapidly and evenly over the whole period at a rate of between 11 and 12 percent per year. The capital-labor ratio in industry more than tripled over the 15 years.

This trend in capital formation, in turn, illustrates the hard core of the Communist doctrine of economic growth -- up to the present at least. Although other priorities and basic economic conditions have changed, an overriding goal in peacetime has been to push the growth of productive fixed capital. When the rate of increase in new investment in industry fell off after 1959, retirement policies apparently were changed to keep up the growth of capital stock.

Given the fixed rate of increase in capital stock and the assumption that capital services vary proportionately with capital stock, any changes in the rate of growth of industrial output must be explained by the behavior of either labor inputs ~~of either labor inputs~~ or factor productivity. The effect of changing rates of retirement of fixed capital on the quality of capital services and thence on output would appear in the trend in factor productivity.

3. Trends in Employment and Man-Hours

Inasmuch as capital services grew steadily over the period, the behavior of labor inputs explains the variation in the growth of the combined

* See Appendix C for a more detailed description of the derivation of the indexes of capital services.

inputs index during 1951-63. The calculations of inputs and factor productivity described above use man-hours as the measure of labor inputs.* Increments in total man-hours sagged drastically after 1955 and actually declined from 1959 to 1961. On the other hand, average annual employment had a distinctly different trend from that of man-hours. Although the rate of increase of industrial employment was reasonably stable during 1951-65 (between 2.4 and 5.4 percent per year), the reduction in hours worked per year by each worker, primarily during 1956-61, brought about a sharp break in the trend of total man-hours worked. Total employment in industry rose by 26 percent between 1955 and 1961, but a reduction of 19 percent in the number of hours spent on the job by each worker during a calendar year resulted in a slight net increase of only 2 percent in total man-hours worked in industry. Most, but not all, of this reduction in hours worked per year was due to a shortening of the workweek.[9]

It has been argued that when hours worked per week are reduced, labor productivity per hour increases.[10] When reductions in the workweek take place in the area of 40 to 50 hours per week (as did the Soviet reductions after 1955), it is difficult to believe that a decline in fatigue is responsible for the major part of any increase in output per man-hour. Instead, it is more likely that improvements in management (perhaps spurred by the imposition of a shorter workweek) and the substitution of capital for labor inputs explain most of this increase. If so, the improved management falls within the definition of productivity gains as used in this paper. To the extent that reductions in the workweek did cause employees to exert more effort per hour after 1955, factor productivity

* See Appendix B for a more detailed description of the derivation of indexes of labor inputs.

gains based on man-hours are overstated in 1956-58 and especially in 1959-61, when the reduction was most rapid.

To minimize the possible impact of hours reduction on labor productivity and therefore on factor productivity, the comparisons of growth of factor productivity can be adjusted by regrouping the data. Of the reduction of 18 percent in hours worked per year per worker between 1955 and 1965, little more than half occurred before 1960, the rest in 1960-64. Thus when the average annual rates of increase in factor productivity in 1956-59 and 1960-64 are compared, the effect of the reduction in man-hours on the relative size of the two rates should be negligible. The decline in annual growth of factor productivity is still striking -- from 5.9 percent per year during 1956-59 to 3.0 percent per year during 1960-64.

Naturally, the rate of growth in factor productivity after 1955 differs markedly, depending on whether man-hours or employment is used to measure the growth of labor inputs. When factor productivity is calculated by using employment for the labor inputs, the gain in productivity is lowest in 1960 and 1961, recovers in 1962 and then begins to fall off again. When man-hours are used, gains in productivity are dampened in 1960-61 and melt away steadily and rapidly from 1962 on. Because of the uncertain impact of the reduction in the length of the workweek on the quality of labor or management, it is impossible to say how much or when factor productivity would have slowed down in the absence of a shortened workweek.

In terms of measuring the change in the efficiency with which

actual inputs are used, man-hours appear to be the suitable yard-stick of changes in labor inputs. From another point of view, however, the growth in factor productivity calculated in terms of employment is of interest. To the Soviet industrial planners the industrial labor force is the labor ~~output~~ input. By carrying out an extensive workweek reduction, the Soviet authorities sacrificed a great deal of potential gain in output; the gap in Table 2 between factor productivity based alternatively on man-hours and employment suggests the extent of this loss, although it is not an accurate measure of the loss because of the interaction between shorter hours, ~~and~~ labor effort, and management initiative mentioned above.

4. Alternative Measures of Factor Productivity

The indexes of factor productivity presented above are based on a particular set of weights for labor and capital inputs and a geometric index formula. The weights reflect (a) an interest rate of 8 percent on gross capital stock, (b) the value of capital stock in 1960, (c) the average annual earnings of labor in 1960, and (d) employment in industry in 1960. The result of using different weights for labor and capital inputs and an arithmetic formula can be judged by examining the data in Table 3, which show four alternative calculations of factor productivity.* 10 If 1950 is used as the base year for calculating the weights of labor and capital inputs and if the interest rate on fixed capital stock is assumed to be 8 percent, as in variant A in Table 3, the weight given to labor inputs is .80 and to capital inputs is .20. In variant B which is used in Table 2 and in the subsequent analysis, an interest rate on capital stock of

* p. 14a, below.

Table 3

USSR: Comparison of Four Variants of Growth in Factor Productivity in Industry, Selected Periods, 1951-65 a/

Variant	Alternative Functions and Weights				Average Annual Rates of Growth of Factor Productivity, Percent			
	Function	Base Year	Interest Rate (Percent)	Labor Coefficients (Percent)	1951-55	1956-58	1959-61	1962-65
A	Geometric	1950	8	80	5.0	6.5	6.4	2.2
B	Geometric	1960	8	72	4.5	5.7	5.4	1.6
C	Geometric	1960	13	64	4.0	4.8	4.5	1.1
D	Arithmetic	1960	8	72	5.2	6.4	5.6	1.2

a. The rates of growth of factor productivity based on the geometric functions (with man-hour labor inputs) are calculated from Table 9, page 54. Variant D has been estimated separately using the same weights and input indexes as in Variant B. The weights are derived in Appendix A, Table 6, page 40.

8 percent is also used by the base year is 1960. Thus the weight for labor inputs falls to .72 and the capital weight rises to .28 because capital stock grew more rapidly than industrial earnings between 1950 and 1960. In variant C the weight attached to labor inputs is still lower (.64) as a result of using an interest rate of 13 percent and 1960 as the base year.

Factor productivity for all industry is also calculated in Table 3 by using an arithmetic production function (variant D) with an 8 percent interest rate and a 1960 base year. A comparison of the growth in factor productivity in variants B and D shows some of the range in possible effects of using different combinations of labor and capital over time. The arithmetic function implies perfect substitutability -- that is, that changing the input mix by increasing one input while holding the other(s) constant results in a constant absolute increase in output. The geometric function, however, projects smaller gains when the input mix is changed: increasing one input while holding the other constant results in decreasing increments to output.[11] When labor and capital indexes are combined ~~arithmetically~~ arithmetically on a 1960 base, factor productivity grows more rapidly before 1960 and less rapidly after 1960, compared to factor productivity calculated with a geometric formula.

Variant B was selected for primary presentation in Table 2 and in the succeeding tables and discussion. This does not mean that variant B is the "right" index, only that it ~~is illustrative~~ represents a middle-of-the-road choice among alternatives. The weights and formula ~~theoretically~~ should reflect the marginal products of capital and labor and the

elasticity of substitution of one for the other. However, as it is not possible to give these theoretical concepts any concrete, statistical meaning in the Soviet context, no attempt has been made to discover the "right" productivity index for the USSR. The use in this paper of Variant B is a convenient simplification, and in any case the analyses and findings of this paper regarding patterns of productivity appear to be valid regardless of the input weights and formula used.

Although these alternative formulations of factor productivity produce a considerable range in the level of productivity gains, they confirm the picture of a general rise in the rate of increase from 1951-55 to 1956-61, followed by a precipitous decline in the rate of advance in 1962-64. It is this pattern of factor productivity, rather than the precise level, that is important for the analysis of recent developments in Soviet industry.

B. Trends in Output, Inputs, and Factor Productivity in the Branches of Industry

1. Branch Coverage

The nine branches discussed in this section are major components of the Soviet industrial classification -- a system quite different from that of the US. In general, mining is not separated from manufacturing in the Soviet system, and most of the branches are highly aggregative: ore mining is lumped together with steelmaking and fabrication in the ferrous metals branch; the petroleum products and natural gas branch includes both extraction and refining; and the forest products branch is an amalgam of timber cutting, wood processing, and paper making. Construction materials includes the mining of

raw materials base excludes steel and timber used in construction. Light industry includes textiles, shoes, and leather products. Chemicals includes rubber and asbestos products.

Within these broad categories, there have been radical changes in the nature of branch output. Thus there has been wide-spread substitution of gas for oil and concrete for brick, and synthetic fibers and plastics have been emphasized at the expense of natural materials. In the machine building industry the relative importance of military hardware probably varied greatly during 1951-64.

The nine branches for which factor productivity trends have been calculated do cover most of industry, however. In 1964 these branches employed 90 percent of industrial workers and had 75 percent of industrial productive capital stock. The only major components of industry excluded are the nonferrous metals and electric power branches, where the information required for the calculations was missing. Because of the breadth of the branch definitions and because of some of the gaps in coverage, the analysis of branch trends which follows is less illuminating than it would be if more disaggregation were possible.

2. Output and Factor Productivity in the Branches of Industry

The indexes of output, combined inputs, and of factor productivity are presented for each of nine branches of industry for 1951-64 in Table 4.* It can be seen from Figure 2** that the differences among the branches in the rate of growth of factor productivity are less than the differences in the growth of aggregate labor →

* Page 17a, below. The indexes run only through 1964, as it is not possible to measure inputs or factor productivity by branch during 1965.
** Following page 17a.

Table 4

USSR: Estimated Average Annual Rates of Growth of Outputs, Inputs, and Factor Productivity in Industry, By Branch

Selected Periods, 1951-64 a/

	1951-64	1951-55			1956-61			1962-64
		1951-55	1951-53	1954-55	1956-61	1956-58	1959-61	
All industry b/								
Output	9.4 ~~9.3~~	11.2 ~~11.1~~	11.2 ~~11.1~~	11.3 ~~11.2~~	9.0 ~~8.9~~	9.5 ~~9.4~~	8.6 ~~8.5~~	7.2 ~~7.0~~
Inputs	4.9	6.4	6.8	5.9	3.3	3.6	3.0	5.5
Factor productivity	~~4.2~~ 4.4	~~4.4~~ 4.5	~~4.0~~ 4.1	~~5.0~~ 5.1	~~5.4~~ 5.5	~~5.6~~ 5.7	~~5.3~~ 5.4	~~1.6~~ 1.7
Ferrous metals								
Output	9.3	11.8	12.7	10.6	8.0	7.3	8.8	7.4
Inputs	5.5	6.4	7.3	5.0	4.4	3.0	5.7	6.1
Factor productivity	3.6	5.1	5.0	5.3	3.5	4.1	2.9	1.2
Coal								
Output	5.7	8.4	6.9	10.8	4.9	8.2	1.7	3.0
Inputs	2.5	6.1	5.0	7.7	0.3	3.9	-3.1	1.3
Factor productivity	3.1	2.2	1.8	2.8	4.6	4.2	5.0	1.6
Petroleum products and natural gas								
Output	13.2	11.8	11.8	11.9	15.4	17.3	13.6	11.4
Inputs	10.3	13.4	12.5	14.9	9.3	10.8	7.9	7.1
Factor productivity	2.7	-1.4	-0.6	-2.6	5.6	5.9	5.3	4.0
Machine building and metalworking b/								
Output	11.9	13.7	13.4	14.1	11.5	10.9	12.0	10.1
Input	5.1	6.0	6.4	5.4	3.6	3.4	3.7	6.5
Factor productivity	6.5	7.2	6.5	8.3	7.6	7.2	8.1	3.3

Table 4

USSR: Estimated Average Annual Rates of Growth of Outputs, Inputs, and Factor Productivity in Industry, by Branch
Selected Periods, 1951-64
(Continued)

	1951-64	1951-55			1956-61			1962-64
		1951-55	1951-53	1954-55	1956-61	1956-58	1959-61	
Construction materials								
Output	14.5	16.5	15.7	17.8	16.6	18.2	15.0	7.1
Inputs	8.2	10.4	11.0	9.5	9.1	10.9	7.4	3.0
Factor productivity	5.8	5.6	4.2	7.7	6.8	6.6	7.1	3.6
Light								
Output	7.0	10.1	11.1	8.7	6.2	7.1	5.2	3.5
Inputs	2.6	5.3	6.1	4.1	0.4	0.1	0.8	2.8
Factor productivity	4.2	4.6	4.7	4.4	5.7	7.1	4.4	0.7
Food								
Output	7.1	9.5	11.5	6.6	7.0	7.8	6.2	3.5
Inputs	3.9	4.9	5.5	3.9	2.5	4.0	1.1	5.0
Factor productivity	3.1	4.4	5.7	2.6	4.3	3.7	5.0	-1.4
Chemicals								
Output	11.5	13.4	13.4	13.4	10.5	11.4	9.6	10.5
Inputs	7.9	7.8	8.1	7.4	4.9	2.9	7.0	14.5
Factor productivity	3.3	5.2	4.9	5.6	5.3	8.3	2.5	-3.5
Forest products								
Output	~~5.2~~ 6.2	~~7.1~~ 7.7	~~6.3~~ 6.8	~~8.4~~ 9.0	~~4.5~~ 5.7	~~6.1~~ 7.0	~~2.9~~ 4.4	~~3.5~~ 4.9
Inputs	0.4	2.9	N.A.	N.A.	-2.7	-1.6	-3.6	2.3
Factor productivity	~~4.8~~ 5.9	~~4.1~~ 4.6	N.A.	N.A.	~~7.3~~ 8.6	~~7.8~~ 8.8	~~6.7~~ 8.3	~~1.1~~ 2.6

a. These calculations are based on the summary data on branches of industry presented in Table 9, Appendix D, p. 54. In each case the growth in inputs and factor productivity relies on the use of a geometric function with input coefficients based on 1960 base-year weights and an interest rate of 8 percent on capital stock.

b. The rates of growth of output (and therefore factor productivity) in industry and machine building and metal working are based on the variant of output in MBMW which incorporates a 20 percent discount of the growth in official GVO.

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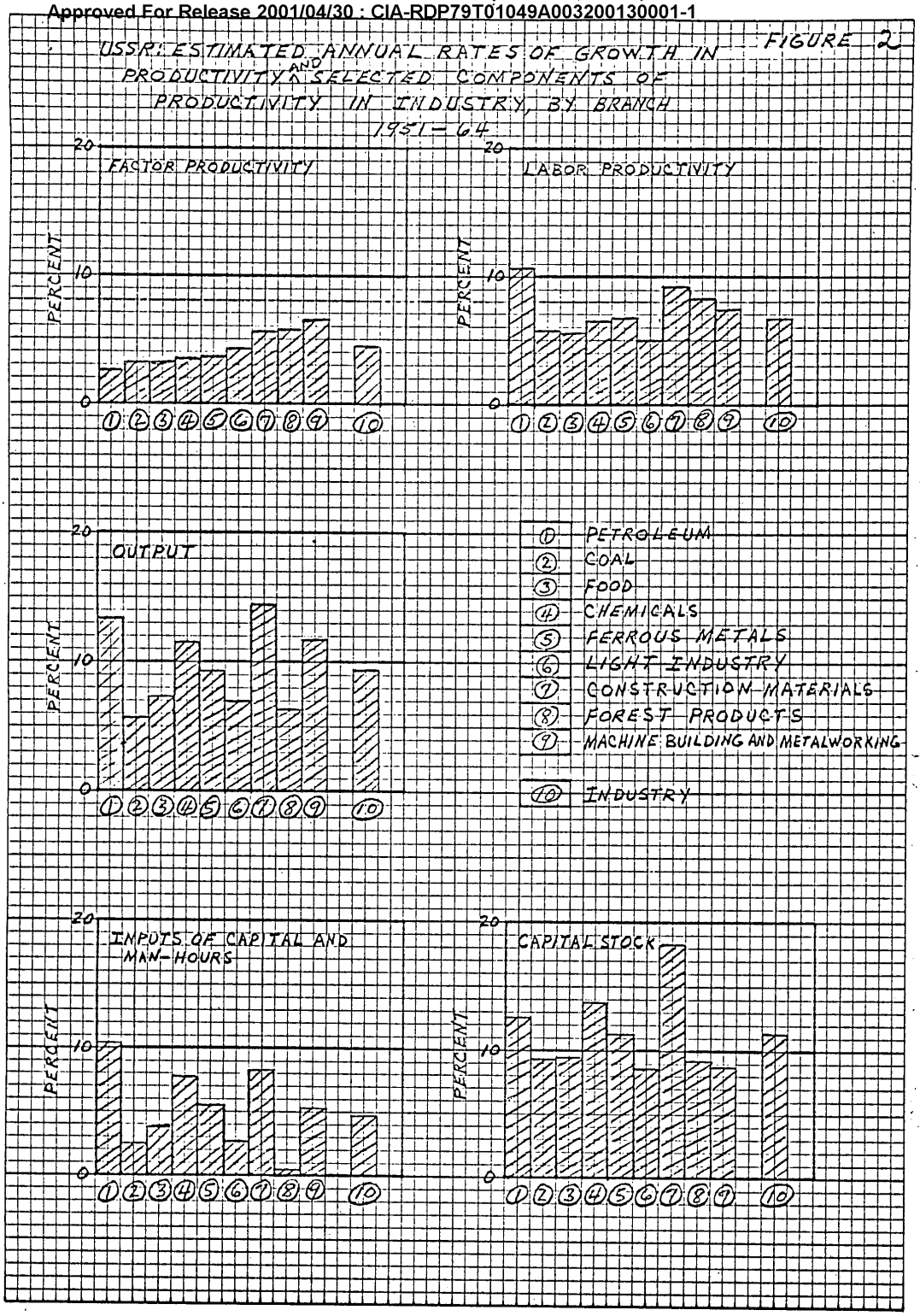
FIGURE 2

USSR: ESTIMATED ANNUAL RATES OF GROWTH IN PRODUCTIVITY AND SELECTED COMPONENTS OF PRODUCTIVITY IN INDUSTRY, BY BRANCH 1951–64



and capital inputs. Therefore, variations among the branches with respect to growth in inputs are a better explanation of branch differences in the growth of output over the period 1951-64 as a whole than are variations in the rate of increase in factor productivity. These differences are discussed in the following section.

Second, it appears that the growth of factor productivity does not correspond closely with the rate of increase in capital stock -- either among the branches or within the same branch over time. Although new technology is introduced in the process of investing, evidently the rate of increase in capital stock is not critical for the trend in factor productivity. The causes of variation in the rate of growth in factor productivity seem to be much more complex. Finally, as one would expect, the growth in labor productivity by branch corresponds loosely to the growth of capital stock but less so to the growth in factor productivity.

Over the whole period 1951-65 three branches in the area of industrial materials -- construction materials, petroleum products and natural gas, and electric power -- boosted their output most rapidly (see Table 5)*. Machine building and metalworking followed in terms of the level of the average rate of growth; it ranked consistently from third to fifth during the four subperiods 1951-55, 1956-58, 1959-61, and 1962-65. The change in the structure of output of industrial materials is shown by comparing the growth pattern of the three leading branches with those of coal and forest products which were quite consistently in 10th and 11th place in a ranking of the 11 branches by rate of growth during the various subperiods. Based on these rankings, it is difficult to

* P. 18a, below.

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Table 5

USSR: Ranking of Branches of Industry According to Rate of Growth of Output, Selected Periods, 1951-65 a/

	1951-65	1951-55	1956-58	1959-61	1962-65
Construction materials	1	1	1	1	6
Petroleum products and natural gas	2	7	2	2	2
Electric power	3	5	3	4	1
Machine building and metalworking	4	3	5	3	4
Chemicals	5	4	4	6	3
Nonferrous metals	6	2	11	5	7
Ferrous metals	7	6	8	7	5
Food	8	9	7	8	8
Light industry	9	8	9	9	11
Forest products (including paper)	10	11	10	10	9
Coal	11	10	6	11	10

a. Based on indexes presented in Table 1, page .

discover any change in the relative emphasis placed upon the consumer goods industries over time; the food and light branches were generally ranked consistently in 8th and 9 th place.

Although Figure 2 reveals a marked similarity in the average annual rates of growth of factor productivity in the individual branches of industry over the whole period, 1951-64, this uniformity disappears when branch trends within this period are examined. In Figure 3* the average annual rates of change in factor productivity year-by-year are presented for all industry and for the nine branches.

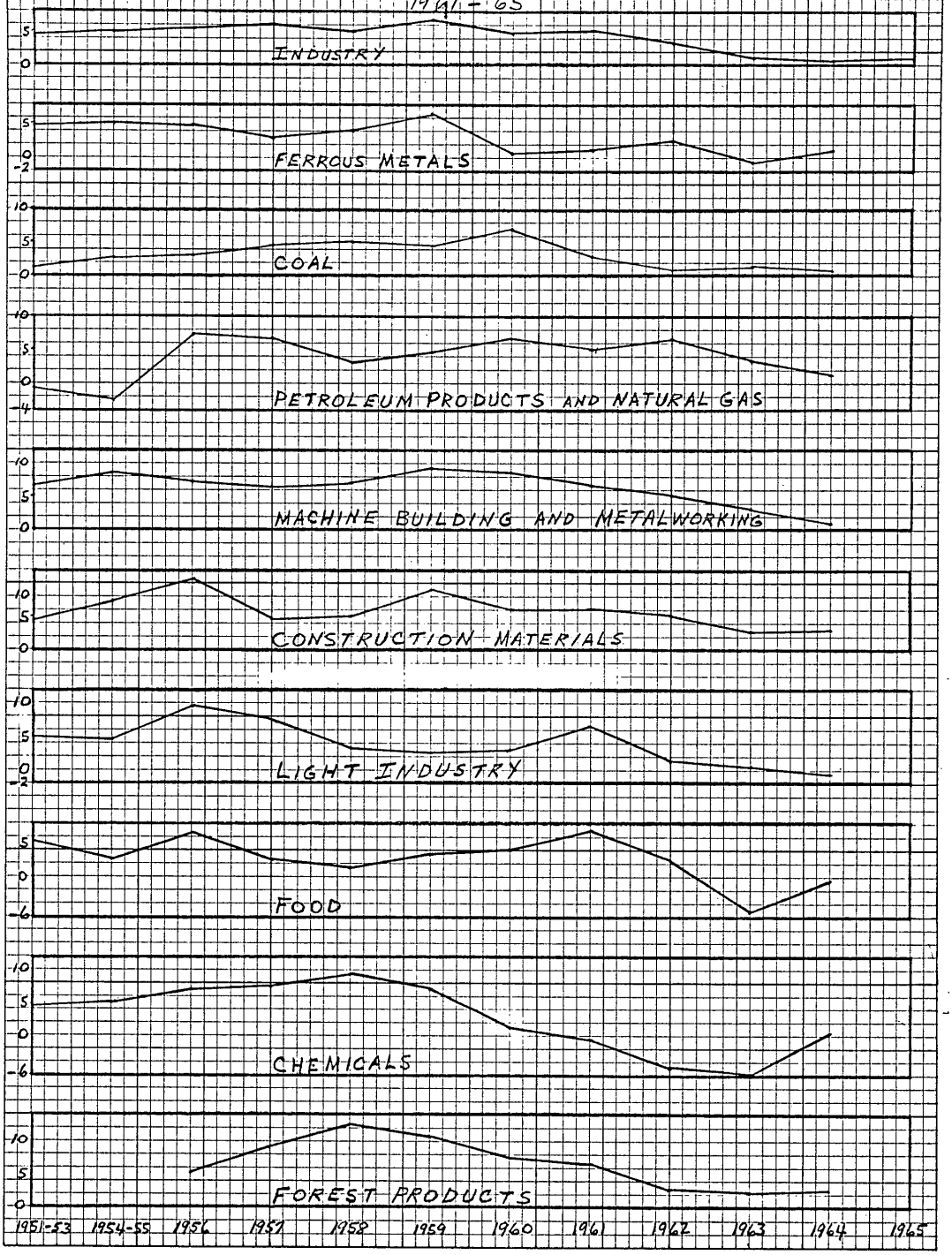
Not one branch follows closely the trend in factor productivity for all industry from the point of view of exhibiting a fairly steady rise in the rate of increase in factor productivity through 1958-59 followed by a slight decline in 1960-61 and a sharp drop thereafter. Percentage gains in the coal, machine building, chemical, and forest products branches of industry, however, do climb upward unevenly, reach a peak in the few years before 1961, and then fall off abruptly. The most pronounced decline in gains in factor productivity occurs in the chemical industry after 1958 at a time when the priority of this branch was increased and the supply of inputs accelerated. Against this background the concern shown by the Soviet leadership over the performance of the chemical industry is understandable. Furthermore, it is conceivable that this very concern has led to a stuffing of inputs into the chemical industry at a rate beyond its capacity to digest.

Three other branches have a somewhat similar pattern of growth in factor productivity. Gains in factor productivity in construction materials and the light and food branches peaked in 1956 before slumping. After some

*. Following p. 19.

FIGURE 3

USSR: ESTIMATED PERCENTAGE CHANGES IN AVERAGE ANNUAL RATES OF GROWTH IN FACTOR PRODUCTIVITY IN INDUSTRY, BY BRANCH 1951 - 65



recovery through 1961, the rate of increase in productivity again falls off sharply. Gains in ferrous metals, in contrast, are quite constant through 1959 before dwindling away. The last branch of industry covered in this report -- petroleum products and natural gas -- displays the most distinctive behavior of factor productivity. After attaining a plateau in 1956-57 the annual rate of increase in factor productivity declines sharply in 1958 and then climbs steeply in 1959-62 only to fall markedly in 1963-64.

These differences in trends in factor productivity among the branches at a given point in time show that rates of growth of productivity in industry cannot be forecast merely by predicting probably changes in the ~~ralative~~ relative importance of the various branches. The high points of gains in factor productivity in the branches of industry are found over a broad span of years. When the rate of increase in factor productivity in industry jumped from ~~5.2~~ 5.2 percent in 1958 to 6.4 percent in 1959, only five of the nine branches managed to raise their percentage gains. Moreover, four of the ~~nine~~ nine branches pushed up their rates of gain in factor productivity in 1960 while the rate of advance fell significantly in industry as a whole. Only in 1962-64 were the changes in the rate of increase in factor productivity in the same direction for almost all branches.

3. Trends in Labor and Capital Services in the Branches of Industry

The ~~inequality~~ unequal provision of additional inputs, as noted earlier, explains most of the difference in rates of growth of the branches of industry. Changes in the rate of increase of weighted inputs were presented in Table 4; underlying trends in labor and capital services are outlined here. Table ~~6~~ 9 in appendix D* presents

* P. 54, below.

industry indexes of output, capital and labor services individually and combined, and the calculations of factor productivity, labor productivity, and capital productivity.

In all of the branches the introduction of a shorter workweek after 1955 produces an uneven rate of increase in man-hour inputs. In addition, the over-all extent of the increase differs greatly among the branches. For the most part the increases were roughly comparable before 1955 but then diverged. By 1962, man-hour inputs in the ferrous metals, petroleum products, and light industry branches were not much different from 1955; in the coal, food, and forest products branches, man-hour inputs were appreciably less in 1962 than in 1955. The large increase in man-hour inputs occurred in machine building, construction materials, and chemicals.

Although the rate of growth in capital stock in all industry was remarkably stable during 1951-64, the growth in the individual branches varies widely over time. For example, the rate of increase of capital stock in the coal industry falls off noticeably after 1959. In light industry the rate of growth picks up after 1958 and in chemicals in 1959 and again in 1962. From 1959 to 1961 the rate of increase in output in chemicals slowed in spite of acceleration of both capital and labor inputs. The trends are consistent with recurrent reports of difficulties in completing new chemical plants and starting production in them.

As a result of the unequal growth of man-hours and capital stock in the branches, the capital-labor ratios changed in quite different degrees. Thus, in construction materials it increased by 430 percent and in

machine building and metalworking by only 84 percent.

Percentage Increase in Capital-Man-Hours Ratio, ~~1950-64~~ 1951-64

Construction materials	- 430	Chemicals	- 219
Forest products	- 332	All industry	- 218
Petroleum products and gas	- 291	Food	- 189
Coal	- 251	Light	- 146
Ferrous metals	- 224	MBMW	- 84

Of course the increase in the capital-labor ratio was particularly large in each branch in the late 1950's when the leadership carried out the reduction in the workweek ~~during the late 1950's~~. These increases in the capital-labor ratio are rather weakly related to the increases in man-hour productivity in these same nine branches.12/

C. Reliability of Results

In spite of the caveats that can be entered in interpreting the results of this paper, it should be pointed out that, for Soviet industry as a whole, the differences in growth of factor productivity in the subperiods are quite large. In particular, the decline in the growth in factor productivity in 1962-64 is substantial and appears in nearly all branches of industry. When alternative methods of weighting inputs are tried, the general trend in factor productivity is not affected greatly. Nevertheless, potential biases abound in a study of this kind. The question is whether these biases might upset the findings outlined above.

First of all, there are many deficiencies in the index of actual output. The output index appears to be the best available but still depends on

the limited amount of physical output data disclosed by the USSR. Then too, the industrial output and MBMW indexes depend on the fairly arbitrary procedure of discounting the growth of the value of output as officially reported for MBMW. One test of the validity of the trends in factor productivity derived with the output index presented earlier is to substitute the official Soviet index of industrial output in the productivity calculations. The average annual rates of growth in factor productivity in industry (in percent) are as follows:

	1951-53	1954-55	1956-58	1959-61	1962-65
Calculated from Soviet output index (GVO)	6.1	6.6	6.5	6.7	2.7
Calculated from the output index used in this paper	4.1	5.1	5.7	5.4	1.6

Although the rate of growth in factor productivity is higher in all periods when the Soviet index is used, the general pattern is similar. Both series show a strikingly similar decline in 1962-65.

The indexes of labor inputs also have their problems. For example, bias in the measure of employment by branch may have arisen because of changes in coverage and reporting of workers in industrial cooperatives. The most important problem in labor trends, however, is the estimate of the timing of the reduction of hours in the branches of industry. The rates of increase in productivity during each year, 1957-61, would be sensitive to changes in this estimate but probably not those of 1962-64 in comparison with the average of preceding years, as the full extent of the reduction is known. The main

difficulties with the capital stock estimates result from the effects of having to use distributions of industry capital stock by branch in terms of original cost of the assets until 1953 in the derivation of the branch indexes. This is more important for trends in factor productivity for branches than for the trend in all industry.

Another source of uncertainty in interpreting the results is the ~~complete~~ absence from the analysis of several factors. Inputs of materials and inventories are not included. The fortunes of the light and food industries, particularly, could be explained with more confidence if more were known about materials availability in 1951-64. Also, the performance of industries such as coal, ferrous metallurgy, and petroleum products and natural gas was influenced by changes in the quality of raw material sources. For example, a substantial part of a new investment in ferrous metals has gone into facilities for the beneficiation of low-grade ores. If the source of raw materials is within the branch, a decline in factor productivity caused by problems in respect to raw materials at least singles out the right branch for blame; when the raw materials source is outside the branch, the factor productivity index may point to the wrong party -- as when coking coal of poorer quality is passed on to the metals branches, dampening gains in productivity in those branches.

III. Causes of the Decline in Soviet Industrial Growth

A. Introduction

From the estimates of industrial growth and input and factor productivity trends presented earlier, it seems apparent that growth in industrial output declined moderately but ~~quite~~ steadily from 1950 to 1964 but that the reasons for the decline ~~were far from being the same~~ varied over the ~~whole~~ period. Through 1955 the effect on individual growth of some decline in the rate of growth of inputs into industry was more than offset by a rise in the rate of increase of factor productivity. From 1956 to 1961, the annual percentage growth in inputs fell so drastically that higher rates of gain in factor productivity could not stave off continuing decline in the rate of growth of industrial production. After 1961, however, as the rate of increase of industrial inputs rebounded sharply, the rate of growth in factor productivity fell so low that the USSR sustained a further drop in the rate of growth of industrial output.

Before discussing some of the possible causes for ~~the observed~~ these changes, it would be appropriate to recapitulate ~~briefly~~ some of the primary findings concerning these trends. Following are the highlights for industry as a whole: (1) the rate of increase in industrial output declined after 1955 from an average annual rate of growth of about 11 percent in 1951-55 to 9 percent in 1956-61 and to 7 percent in 1962-65; (2) total employment and capital stock grew at a relatively steady pace -- 2.4 to 5.4 percent a year for increases in the labor force and a steady annual net increase of 11 to 12 percent in reproducible assets; (3) total man-hours worked annually between 1955 and 1961 remained practically unchanged

as the growth in the labor force was offset by a gradual 7-hour reduction in the scheduled workweek and by the increase in days off for vacations and sickness; (4) the reduction in man-hours worked led to a halving of the annual increment in aggregate inputs after 1955 -- roughly from an average of 6.4 percent in 1951-55 to 3.3 percent in 1956-61; (5) meanwhile, the rate of increase in over-all factor productivity trended upward throughout the 1950's, reached a peak in 1956-58, declined slightly in 1959-61, and dropped sharply in 1962-65.

B. Long Run Factors Affecting Industrial Growth During the 1950's.

Although many developments of the last 15 years contributed to the trends in output and productivity, two factors during the postwar period tended to bolster factor productivity gains and therefore growth in industrial output. Yet, the steam imported to industrial growth by both factors apparently diminished by the end of the 1950's.

During 1946-50, rapid recovery from wartime disruption in the USSR was accompanied by high rates of growth in industrial production and factor productivity as in most other war-damaged nations. Raymond P. Powell's computations for this period suggest average annual rates of increase in factor productivity in the USSR of 7 to 8 percent.[13] In addition to the usual gains from reconstruction, important gains were achieved in the adoption of advanced technology as investment in new industrial plant and equipment proceeded. Soviet industrial technology was far behind that of the West before World War II, and further Western advances during the war created more opportunities for borrowing and

catching up. Moreover, as an indirect result of the war, there was an opportunity to import new production techniques from the West through wartime contacts with the Allies; lend-lease aid; postwar reparations from Germany and Eastern Europe; and the use of captive services of engineers, designers, and scientists from the occupied areas. As the Soviet authorities reduced the gap between their own and Western technology, a slowdown in productivity gains could be anticipated. But this catching up phase certainly had not ended by the early 1950's, and important economies in inputs based on catching up probably were being made until at least the middle of the decade. In this over-all view of the postwar record the rapid deceleration in growth in factor productivity in 1951-53 appears as a temporary aberration. The most important reason for the abrupt decline appears to have been the rapid step-up in armaments production during the Korean War. The disruptions attending the acceleration of industrial support to the military establishment, especially in machine building, probably restricted the secular increase that would have ensued under normal conditions.

It is doubtful that much of this improved technology is reflected in the indexes of capital stock used in this paper. Therefore, if the USSR was operating within the frontier of technological knowledge and was "borrowing" technology, the results would be reflected in the growth of factor productivity. As the frontier is approached, the potential for such borrowing diminishes and the rate of growth of Soviet technological progress (as well as output and factor productivity) should fall off.

Another factor related to input quality appeared to hold up the rate of industrial growth during the 1950's. The educational attainment of the labor force seems to have increased at a rapid rate at least through 1959 but then the growth slowed down. This judgment relies on the belief that calculations of the stock of human capital in the Soviet labor force prepared by Nicholas DeWitt for 1959 and earlier years and carried forward to 1965 also correctly describe the industrial labor force.[14] The results of these calculations are summarized in the following tabulation.

Average Annual Increases in Human Capital (Percent)

Years	Total Human Capital in Labor Force	Human Capital Per Worker
1951-59	7.1	4.9
1960-62	4.6	3.1
1963-64	4.6	2.8

In these estimates the increase in human capital represents the amount of accumulated investment embodied in the formal education of that labor force. The total of this investment[15] at any given time can be thought of as the value of the stock of human capital gainfully occupied in economic activity. Large investments in the schooling of its potential labor supply have resulted in a phenomenal increase in the formation of human capital embodied in the average employed person in the USSR. For example, the total stock of human capital increased at an average annual rate of 7.1 percent during 1951-59 compared with an average annual increase of 2.1 percent in the total number of persons gainfully occupied in economic activity. Thus there was nearly a 5 percent annual rate of increase in total investment per worker through the attainment of additional education.[16]

The decline in the rate of growth in human capital per worker is more relevant for the course of output and factor productivity in industry.

Unless →

increase of the better educated, it too must have ~~forced~~ faced an erosion in the rate of increase of the quality of its work force -- at least as measured by educational attainment.[17] An additional factor that tended to enhance the quality of the civilian labor force in 1956-59 -- a reduction in the size of the armed forces -- failed to contribute significantly in the recent period. The total ~~announced~~ net reduction in the armed forces of 2.2 million in 1956-59 does not seem to have ~~been~~ continued on anything like the same scale, Available evidence suggests that, because of in-service training, the skill level of ex-service men is above that of workers with comparable formal education. In contrast, the growth of the employed labor force in 1959-65 included a rising share of relatively inexperienced teenagers and housewives.

While these two factors related to the quality of capital and labor services were at work, another development was making it more difficult for the Soviets to keep up the rate of growth of industrial production. In every one of the nine branches of industry examined as well as in industry as a whole, the capital-labor ratio was rising sharply. It was not possible to push additional labor into industry as fast as capital stock was increasing. Given less than perfect substitutability of capital for labor, this should have meant that increasing quantities of net investment were required with a given increase in man-hours to get the same increase in combined labor and capital inputs.

Another potential factor tending to depress factor productivity and output gains applies to the extractive industries. In ferrous and nonferrous

metals the large investments devoted to mining and treating low-grade ores retard productivity and output gains. 18/ There simply is not a sufficient supply of ores of equal quality available for exploitation, particularly when output is expanding so rapidly.

C. Spurt in Factor Productivity, 1954-58

Despite the long run factors tending to pull down the growth in output and factor productivity during the 1950's, factor productivity gains clearly surged upward in 1954-55 and 1956-58. It is tempting to explain part of this spurt by the political history of the time. The death of Stalin and the end of the Korean hostilities may have stimulated the growth of factor productivity. The simple relaxation of terror and the lifting of the more heavy-handed controls probably fostered some of the productivity gains revealed in the statistics. Factor productivity increased from 4.1 percent annually in 1951-53 to 5.1 percent in 1954-55 and 5.7 percent in 1956-58.

Then, too, the reorganization of 1957 to the sovnarkhoz system may have given a temporary boost to efficiency by correcting a few of the most glaring weaknesses in the management of industry. Despite the abuse heaped on the ~~sovnatkhoz~~ sovnarkhozy, the old ministerial system probably had become so fossilized that any shake-up might have helped efficiency.

The increase in the rate of growth of factor productivity which kept up the growth in industrial production after 1955 also coincided with the reduction in the length of the work week. The regime placed particular emphasis on tieing both the reduction in hours and the wage reform to the uncovering of intra-enterprise reserves. This pressure undoubtedly succeeded to some extent, but it is important →

to note that any such gains in efficiency were by their nature one-time gains. Internal reserves insofar as they represented inefficiencies in the organization of production could not be "uncovered" repeatedly.

In this somewhat eclectic survey of possible reasons for the increase in factor productivity growth in the 1950's, the change in the structure of industrial investment is worth mentioning. The capital stock indexes used in this paper assume that the marginal productivity of additional capital in the form of buildings and structures is equal to that of equipment. This is probably untrue; at least the Soviets believe it is not so. They have stressed the importance of raising the equipment portion of investment as a means of reversing the unfavorable trend in the out-capital ratio.[19] From 1950 to 1955 the share of equipment in industrial investment fell from 40 percent to 33 percent. It then rose to 37 percent in 1956 and to an average of 40 percent during 1957-1960.[20]

Finally, the decline in the size of the armed forces announced by Khrushchev after 1955 may have been accompanied by a reduction in defense expenditures for a few years at least. In any case the effect would have been to dampen the competition for skilled scientific and technical civilian manpower and to release trained manpower from military service.

D. Deceleration in Growth of Factor Productivity after 1959.

The highest rate of increase in factor productivity in industry during the 15-year period 1951-65 came in 1959 with an increase of 6.4 percent. This peak was followed by a rapid deceleration to 4.9 and 5.0 percent in 1960 and

1961, ~~2.8~~ 3.0 percent in 1962, ~~1.3~~ 1.4 percent in 1963, and ~~0.7~~ 0.9 percent in 1964, and 1.4 percent in 1965. As suggested above, some part of this decline must have been a normal aftermath of the postwar recovery surge and hence is likely to be permanent. However, recent developments determined the timing and abruptness of the decline and contributed substantially to its magnitude. The effect of these factors is either temporary or at least subject to change in the sense that policy decisions of the Soviet government could reverse or offset them.

The abruptness of the decline in gains in factor productivity in 1962-65, after the reduction in the workweek had been completed, raises the question of the impact of declining man-hours per worker on productivity. The earlier discussion of factor productivity calculated with employment rather than man-hours as the labor input suggested that in the absence of a reduction in the workweek the decline might have begun in 1960 instead of 1962 and thus might have been less abrupt. Second, to the extent that enterprise managers were successful in increasing productivity during 1956-59, they may have temporarily reduced opportunities for further increases after 1959.

A number of other recent developments in the use of labor and capital could have contributed to the decline in annual growth of factor productivity, as follows:

a. During 1960-63 there was a significant slowdown in the growth of new investment in industry as a consequence, perhaps, of an increase in defense and space expenditures or simply the much discussed problems on the construction front. In the face of this decline in investment growth, industrial capital stock continued to rise with undiminished vigor. A comparison of investment (less the change in unfinished construction) with the

change in capital stock in industry indicates that the Soviets may have reduced the rate of retirement of old capital assets by ~~almost~~ more than one-half after 1959. 21/

In order to maintain old plant and equipment, capital repairs for the economy (and presumably for industry) have accelerated, growing at a planned average rate of 11.8 percent in 1960-63 compared with 5.3 percent in 1956-59. 22/ The failure to introduce new plant and equipment into production at previous rates of growth probably has been a factor in the reduced growth of factor productivity. Old equipment that has been overhauled plainly does not introduce new technology in the way that brand-new equipment can and usually does. 23/

b. Even in the branches of industry where gross and net capital formation have accelerated since 1959, the productivity performance has been poor. In the chemical industry, for example, factor productivity has actually declined. Evidence from Soviet publications and the observations of foreign visitors suggest abnormally low operating efficiency in newly constructed enterprises, especially in chemical plants incorporating new technology. Thus much of the sharp decline in productivity may be related to difficulties in assimilating the huge chunks of new capacity that ~~embodies~~ technology relatively new to the Soviet scene. This failure to digest new technology appears to be due in part to poor design and incompetent assembly and installation work and in part to the lack of trained operating personnel. 24/

This performance appears to be the by product of the general trend toward a more complex and sophisticated industrial sector. The impact of these departures from the old paths of development may be seen in the relation of factor productivity gains to increases in capital stock in industry and the branches of

industry. It would be expected that rapid increases in capital stock would tend to favor productivity gains through the medium of "embodied technology". Yet the association of factor productivity growth with growth in capital stock in Soviet industry has been low or even negative. 25/ 24/

c. In some branches of industry, notably the light and food branches, the poor output and productivity records of recent years are certainly explained in large part by a shortage of raw materials caused by harvest failures. In light industry, changing consumer preferences have forced changes in the output mix that may have cut output and productivity gains ~~temporily~~ temporarily.

d. ~~Another~~ A factor that may have contributed to the recent decline in growth in factor productivity is the significant dropoff in the contribution of education ~~in~~ increased toward raising the quality of the labor force. The extent of this decline and its potential importance was discussed above.

e. There is another plausible ~~although difficult to appraise~~ reason for the ~~seeming~~ paradox of rapid formation of new capital associated with the deceleration of the growth of productivity. It seems clear that the Soviets have spent increasingly large sums since the mid 1950's on military and space hardware and on military research and development. The rates of growth of civilian machinery output and investment in machinery and equipment cannot be reconciled with the announced rates of growth of machine building and metal working output unless there have also been substantial increases in the production of military machinery.

This expansion probably has been particularly large in programs -- for example, advanced weapons and space -- that directly compete with those investment needs of industry requiring complex machinery and highly skilled scientific

and technical manpower. Thus a diversion, in large quantities, of highly specialized and scarce resources to military and space programs may be of major importance in explaining the recent decline in factor productivity in industry. 26/

E. Prospects for Growth in Industrial Output in the New Five Year Plan (1966-70)

Whether the recent slump in the growth of factor productivity will continue, level off, or reverse itself has, of course, particular importance for future Soviet development. It is unlikely that the USSR can continue to increase inputs into industry at the rate of the early and mid-1950's, The well-publicized discussions in the USSR of incentives, efficiency, and planning techniques testify to the official concern over this question.

Leonid Brezhnev in his address to the 23rd Congress of the Communist Party noted the official disappointment over industrial performance. He also stated his belief that the September 1965 program for economic reform in industry had prepared the way for restoring higher rates of growth in output and productivity in industry. 27/ This belief is imbedded in the new five year plan (1966-70) which calls for a 47-50 percent rise in industrial output and a 33-35 percent increase in labor productivity by 1970. 28/

The planned average annual increase in industrial output of 8.0-8.4 percent during 1966-70 seems cautious enough. It would not bring back the rates of increase estimated for 1959-61 in this paper, much less those claimed by the Soviets. Nonetheless, a tentative calculation based on the labor productivity goals and the incomplete plans for industrial investment shows that even this modest proposal depends for its success on a sharp recovery in the growth of factor productivity. 29/ From an average annual increase of 1.6 percent in 1962-65, the rate of increase of factor productivity would have to bounce back to 4.1 percent.

[redacted] during 1966-70. [30] This implied rate of gain in productivity would almost recapture the successes of 1960-61, when the average annual rate of growth of factor productivity leveled out at 5.0 percent per year before plunging downward.

It would not be surprising to see productivity rebound to some extent. The performance of Soviet agriculture should improve, to the benefit of the light and food branches, and the stabilization of the workweek should also help. To the extent that the pressures surrounding the introduction of a shorter work week "borrowed" efficiency gains from future periods, productivity gains in the recent past have been depressed unnaturally. Still no convincing appraisal of the realism of the new five year plan in industry can be made without a knowledge of the probable effects of the managerial reform in industry, particularly over the next three or four years when the reform is being introduced. Such a judgment is far beyond the bounds of this paper.

Appendix A

Derivation of the Index Formula Used in Calculating Factor Productivity

The index formulas or the production functions used to aggregate inputs are of two kinds: a geometric function of the Cobb-Douglas type and an arithmetic function. The geometric function is of the form $P_t = cL_t^a K_t^b$ and the arithmetic function is of the form $P_t = e\ (w_o L_t + r_o K_t)$ where

P_t	=	predicted output in year t resulting solely from increase in inputs
L_t and K_t	=	labor and capital inputs in year t
a and b	=	labor and capital coefficients
c, e	=	multiplicative constants
w_o and r_o	=	price of labor and capital inputs in the base period
a + b	=	1

The geometric function is used predominantly in the calculation of factor productivity in this paper; the results of using arithmetic function are shown only for all industry. If it is assumed that both labor and capital inputs are paid the value of their marginal product in the base period, it can be shown that the values of a and b for the geometric function are equal to their proportionate share of value added in the given sector of production in the base period. The geometric function can be converted into a ratio of predicted output:

$$\frac{P_t}{P_o} = \frac{L_t^a K_t^b}{L_o^a K_o^b} = \left(\frac{L_t}{L_o}\right)^a \left(\frac{K_t}{K_o}\right)^b$$

Similarly the arithmetic function can be transformed into a ratio of predicted output with coefficients a and b equal to those used in the geometric function:

$$\frac{P_t}{P_o} = a \frac{L_t}{L_o} + b \frac{K_t}{K_o}$$

The shares of labor and capital in total value added (and therefore values for the coefficients a and b) for all industry and for the branches of industry must be contrived. In the calculation the aim is to approximate the relative marginal products of labor and capital.

First, average annual earnings of workers and employees together with social insurance deductions are taken to reflect the values of the marginal product of labor for industry as a whole and for the various branches of industry. This assumption has been implicit in other studies and is adopted here in the belief that the degree of mobility in the Soviet labor market is sufficient to make relative wages correspond to relative marginal productivity. The average annual earnings multiplied by the number of workers and employees is taken as the absolute share of labor inputs in total value added. Two years, 1950 and 1960, are used as base years in order to make it possible to appraise the effect on the production functions of changing input mixes, relative factor earnings, and technologies employed.

The calculation of return to capital requires that a rate of return be applied to estimates of average underpreciated fixed capital stock on hand in industry and the industrial branches in 1950 and 1960, valued in 1955 prices. Undepreciated or gross fixed capital stock is used in the calculation in the belief that the services of capital stock do not decline through time nearly as rapidly as the application of straight-line depreciation would imply. Therefore,

when capital stock is increasing, the deduction, for example, of straight-line depreciation from gross capital stock overstates the loss in its input efficiency. On the other hand, the additions to capital stock tend to be more productive than the stock going out of service, so that in this respect a gross capital stock series understates the trend in capital services.

The rate of return itself is a combination of interest charges and depreciation charges. In the absence of any knowledge as to what would be a correct interest rate, rates of 8 percent or 13 percent are employed.[31] The depreciation charges for each industrial sector are the amortization rates recently introduced in the USSR for fixed assets. This gives a rate of return of 11 to 15 percent using an interest rate of 8 percent and a rate of return of 16 to 20 percent using an interest rate of 13 percent. The steps taken in the computation of these production function coefficients are summarized in Table 6. Although every step in the derivation of these coefficients involves some estimation, the wide range in the value of the coefficients derived gives some expression to the underlying uncertainties. In calculating factor productivity indexes, all of these coefficients are used because there is no good reason for preferring one to another.

Table

USSR: Derivation of Estimated Production Function Coefficients

Branch	Base Year	(1) Employment of Workers a/ (Thousand Persons)	(2) Ratio of Workers and Employees to Workers b/ (Thousand Persons)	(3) Employment of Workers and Employees c/ (Thousand Persons)	(4) Average Annual Earnings d/	(5) Social Insurance Deductions as Share of Wage Fund e/ (Percent)	(6) Labor Costs f/ (Billion New Rubles)	(7) Productive Fixed Capital g/ (Billion New Rubles)	(8) Amortization Charge h/ (Percent)	(9) Capital Cost Billion Rubles i/	(10) Capital Cost Billion Rubles j/	(11) Total Labor and Capital Cost Billion Rubles k/	(12) Total Labor and Capital Cost Billion Rubles l/	(13) Labor Coefficient m Column 6 Divided by Column 11	(14) Labor Coefficient m Column 6 Divided by Column 12
Industry	1950	12,289	(1.251)	15,374	866	6.8	14.22	29.10	4.14	3.53	4.99	17.75	19.21	.80	.74
	1960	18,574	(1.200)	22,289	1,096	7.0	26.14	85.09	4.14	10.33	14.58	36.47	40.72	.72	.64
Ferrous metals	1950	604	(1.232)	744	1,132	7.9	.91	2.90	3.51	.33	.48	1.24	1.39	.73	.65
	1960	886	(1.182)	1,047	1,393	7.9	1.57	8.24	3.51	.95	1.36	2.52	2.93	.62	.54
Coal	1950	732	(1.209)	855	1,465	9.0	1.41	2.61	6.59	.38	.51	1.79	1.92	.79	.73
	1960	1,031	(1.160)	1,196	2,036	9.0	2.65	7.27	6.59	1.06	1.42	3.71	4.07	.71	.65
Petroleum products and natural gas	1950	92	(1.380)	127	1,028	8.4	.14	1.61	6.59	.23	.32	.37	.46	.38	.30
	1960	148	(1.324)	196	1,235	8.4	.26	6.09	6.59	.89	1.19	1.15	1.45	.23	.18
Machine building and metalworking	1950	3,314	(1.305)	4,325	915	7.5	4.25	7.74	3.71	.91	1.29	5.16	5.54	.82	.77
	1960	5,655	1.252	7,080	1,102	7.5	8.39	16.96	3.71	1.99	2.83	10.38	11.22	.81	.75
Construction materials	1950	567	(1.189)	674	763	6.1	.55	.75	4.45	.09	.13	.64	.68	.86	.81
	1960	1,310	(1.140)	1,493	1,033	6.1	1.64	4.70	4.45	.59	.82	2.23	2.46	.74	.67
Light	1950	2,267	(1.204)	2,729	639	6.8	1.86	1.70	3.60	.20	.28	2.06	2.14	.90	.87
	1960	3,371	(1.155)	3,894	818	6.8	3.40	3.79	3.60	.44	.63	3.84	4.03	.89	.84
Food	1950	1,320	(1.283)	1,694	582	6.8	1.05	3.19	3.64	.37	.53	1.42	1.58	.74	.66
	1960	1,743	(1.231)	2,146	821	6.8	1.88	7.70	3.64	.90	1.28	2.78	3.16	.68	.59
Chemicals	1950	365	(1.318)	481	887	8.4	.46	1.33	3.54	.15	.22	.61	.68	.75	.68
	1960	584	1.265	739	1,135	8.4	.91	4.25	3.54	.49	.70	1.40	1.61	.65	.57
Forest products	1950	---	---	2,779	734	4.7	2.14	2.06	5.83	.28	.39	2.42	2.53	.88	.85
	1960	---	---	2,598	1,023	4.7	2.78	4.98	5.83	.69	.94	3.47	3.72	.80	.74

a. From Table 7, Appendix B, p. 44a, below.

b. These ratios for all industry in 1950 and in 1960 and for 1960 in the ferrous metals, coal, petroleum products and natural gas, construction materials, light, and food branches are derived from reported numbers of industrial production personnel and wageworkers. U.S.S.R., Central Statistical Administration, "Promyshlennost' SSSR," Moscow, 1964, p. 85, 158, 186, 314, 354, and 424. The 1960 ratio for MBMW is the ratio for MBMW in the R.S.F.S.R. U.S.S.R. Central Statistical Administration, "Promyshlennost' RSFSR," Moscow, 1961, p. 36. The 1960 ratio for chemicals is based on the ratio for 1955 as reported in N.N. Nekrasov, "Ekonomika khimicheskoy promyshlennosti," Moscow, 1959, p. 331. The ratio for 1955 was moved forward to 1960 on the basis of the change in the ratios for industry as a whole. All of the branch ratios for 1950 are equal to the 1960 ratios adjusted by the change in the ratio for industry as a whole.

c. Number of workers and employees are either given in Soviet statistical handbooks or are estimated by multiplying the number of workers in column 1 by the ratios in column 2. (See f.n. b., above). The figure for workers and employees in forest products for 1960 is from "Promyshlennost' SSSR," op. cit., p. 291, and the 1950 figure is derived from the 1960 figure and the index of employment in Table , p. .

d. Average annual earnings in industry and the branches of industry are estimated from the following sources: Earnings in Industry - U.S.S.R., Central statistical Administration, "Narodnoye khozyaystvo S.S.S.R. v 1964 godu", Moscow, 1965, p. 555; "Finansy SSSR," no 7, 1962, p. 5; "Ekonomicheskaya gazeta, April 23, 1962, p. 91; L.A. Blyakhman "Proizvoditel'nost' i oplata truda v period razvernutogo stroitel'stva kommunizma," Leningrad, 1964, p. 313, 320; D.N. Karpukhin, "Sootnosheniye rosta proizvoditel'nosti truda i zarabotnoy platy," Moscow, 1963, p. 168. Earnings in branches of industry -- "Trud i zarabotnaya plata," no 10, 1961, p. 24; Karpukhin, op. cit., p. 168; I.A. Orlovskiy and G.P. Sergeyeva, "Sootnosheniye rosta proizvoditel'nosti truda i zarabotnoy platy v promyshlennosti SSSR," Moscow, 1961, p. 44, 51; A.G. Aganbegyan and V.F. Mayer, "Zarabotnaya plata v SSSR," Moscow, 1959, p. 187; Blyakhman, op. cit., p. 322. No increase in wages of workers in construction materials between 1959 and 1960 has been reported, so it was assumed to be 2 percent. In both 1950 and 1960 the ratio of earnings of workers and employees to earnings of workers was estimated from reported distributions of employees given in various statistical handbooks and from earnings ratios for various categories reported in Orlovskiy and Sergeyeva, op. cit., p. 53; Aganbegyan and Mayer, op. cit., p. 201-202; V.N. Yagodkin, "Osnovye zakonomernosti vosproizvodstva rabochiy sili v period na razvernutogo stroitel'stvo kommunizma," Moscow, 1965, p. 133; and "Sotsialisticheskiy trud," no 9, 1960, pp. 6-7.

e. Social insurance deduction rates for the branches and taken from V. Krulikovskaya, et. al., "Planirovaniye byudzheta gosudarstvennogo sotsial'nogo strakhovaniya," Moscow, 1959, pp. 17-18. The rate for all industry is a weighted average of the branch rates.

f. (Column 3 times column 4) + column 5 (column 3 times column 4).

g. Capital stock 1 Jan 1960 (as reported in "Narodnoye khozyaystvo SSSR v 1959 godu," pp. 67-68) has been converted to an average annual basis for 1950 and 1960 by the the indexes of capital stock presented in Table 8, p. 52a, below.

h. "Actual amortization" (excluding that for capital repair) according to the new norms introduced on Jan. 1, 1963. U.S.S.R. Academy of Sciences, Institute of Economics, "Teoriya amortizatsii i technicheskiy progress," Moscow, 1965, p. 155. The rate given for the fuel industry was used both for coal and for petroleum products and natural gas.

i. Column 7 times the sum of column 8 and an 8 percent interest charge on capital stock.

j. Column times the sum of column 8 and a 13 percent interest charge on capital stock.

k. Column 6 plus column 9.

l. Column 6 plus column 10.

m. The capital coefficients for each sector are equal to 1 minus the value of the labor coefficients.

Appendix B

Derivation of Indexes of Labor Inputs

I.

~~A.~~ Description of Indexes of Labor Inputs

The indexes of labor inputs rely on published Soviet data on employment of wageworkers in industry and by branch of industry. Although it would be better to use data on all wage and salary workers involved in the production process, such data are ~~this is~~ available through time only for industry as a whole.[33] Moreover, the ratio of wageworkers to wage and salary workers in industry has not changed so much as to cast doubt on the use of labor inputs series based on employment of wageworkers as representative of total employment trends. An employment index derived from labor productivity data was used for all years for the forest products industry. Alternative indexes of labor inputs reflecting man-hours worked are computed by applying branch indexes of hours worked per year per man to the employment indexes. The indexes of the length of the workday and the number of days worked per year are based on data reported in the Soviet yearbooks and in articles reporting on the progress of the reduction of hours in industry.

The problem of matching the coverage of inputs against the coverage of outputs appears in the case of the labor inputs indexes. Conceptually the output indexes cover all output of a given classification whether produced in the given branch, in other branches, or in nonindustrial sectors.[33] Reported branch employment data, however, are on an enterprise basis, so that workers in a given plant are classified according to the character of its primary output. Moreover, they exclude industrial employment in industrial cooperatives or in agriculture.

In contrast, inputs series derived from labor productivity and gross output data are based on employment which includes in some cases all industrial production personnel rather than just "workers" and also workers in those producer cooperatives classified under industry. For some branches, moreover, labor productivity is calculated only for a major segment of the branch, such as coal extraction and timber cutting within the coal and logging branches. A particularly difficult problem results from the Soviet transfer of industrial cooperatives into state industry in 1956 and in 1960. As the reported employment data include these transferees, the reported data must be adjusted to prevent an overstatement of the growth in industry and branch employment.

In spite of the adjustments applied to the data, the mismatching of labor inputs and outputs resulting from differing coverage probably results in an understatement of the growth in factor productivity. This follows from the belief that there has been a trend toward specialization in industrial production and that employment of an industrial character outside of industry has not been increasing as rapidly as employment in industry. For particular branches of industry the net effect of using employment classified on an establishment basis rather than on a product basis to measure labor inputs is difficult to gauge. Nevertheless, it should be remembered that branches vary greatly in terms of the extent to which they specialize in production of their primary product and the proportion of total output of their primary product that they account for. For this reason, interbranch comparisons of factor productivity based on the sort to labor inputs indexes used in this paper must be viewed with caution.

~~footnotes to be added~~

1 For derivation of [illegible], see text [illegible]
Appendix C.

Table 7

USSR: Employment and Indexes of Labor Services in Industry, by Branch
Selected Years, 1950-64

Branch	1950	1952	1953	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964
Industry													
Employment (thousand wageworkers a/)													
Reported	11,308	12,474	13,179	14,281	15,226	15,760	16,279	16,793	18,574	19,548	20,176	20,760	21,435
Estimated industrial cooperative component	981	1,133	1,215	1,263	825	675	825	900	---	---	---	---	---
Adjusted	12,289	13,607	14,394	15,544	16,051	16,435	17,104	17,693	18,574	19,548	20,176	20,760	21,435
Indexes of labor services (1950 = 100)													
Adjusted employment	100.0	110.7	117.1	126.5	130.6	133.7	139.2	144.0	151.1	159.1	164.2	168.9	174.4
Hours worked per year	100.0	99.5	99.3	98.9	96.0	94.1	91.8	89.4	84.8	80.1	79.9	80.2	80.8
Man-hours	100.0	110.1	116.3	125.1	125.4	125.8	127.8	128.7	128.1	127.4	131.2	135.5	140.9
Ferrous metals													
Employment (thousand wageworkers)													
Reported	604	675	706	742	751	764	812	841	886	923	947	979	1,009
Indexes of labor services (1950 = 100)													
Reported employment	100.0	111.8	116.9	122.8	124.3	126.5	134.4	139.2	146.7	152.8	156.8	162.1	167.1
Hours worked per year	100.0	99.5	99.3	98.9	96.0	91.6	85.4	81.8	81.4	80.1	79.9	80.2	80.8
Man-hours	100.0	111.2	116.1	121.4	119.3	115.9	114.8	113.9	119.4	122.4	125.3	130.0	135.0
Coal													
Employment (thousand wageworkers)													
Reported	732	763	793	897	968	1,021	1,071	1,074	1,031	1,005	996	986	988

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USSR: Employment and Indexes of Labor Services in Industry, by Branch
Selected Years, 1950-65
(Continued)

Branch	1950	1952	1953	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
Indexes of labor services (1950 = 100)														
Reported employment	100.0	104.2	108.3	122.5	132.2	139.5	146.3	146.7	140.8	137.3	136.1	134.7	135.0	
Hours worked per year	100.0	99.5	99.3	98.9	96.0	91.5	85.6	80.0	75.5	72.6	72.3	72.6	73.2	
Man-hours	100.0	103.7	107.5	121.2	126.9	127.6	125.2	117.4	106.3	99.7	98.4	97.8	98.9	
Petroleum products and natural gas														
Employment (thousand wageworkers)														
Reported	92	103	109	124	127	130	140	143	148	157	154	~~161~~ 154	(156)	
Indexes of labor services (1950 = 100)														
Reported employment	100.0	112.0	118.5	134.8	138.0	141.3	152.2	155.4	160.9	170.7	167.4	~~175.0~~ 167.4	(169.6)	
Hours worked per year	100.0	99.5	99.3	98.9	96.0	94.4	93.6	90.6	84.7	80.4	80.1	80.5	81.1	
Man-hours	100.0	111.4	117.7	133.3	132.5	133.4	142.5	140.8	136.3	137.2	134.1	~~140.9~~ 134.8	(137.5)	
Machine building and metalworking														
Employment (thousand wageworkers)														
Reported	3,216	3,581	3,837	4,256	4,539	4,736	4,932	5,149	5,655	6,207	6,586	6,938	7,249	
Estimated industrial cooperative component	98	133	122	126	82	68	82	90	---	---	---	---	---	
Adjusted	3,314	~~3,694~~ 3714	3,959	4,382	4,621	4,804	5,014	5,239	5,655	6,207	6,586	6,938	7,249	
Indexes of labor services (1950 = 100)														
Adjusted employment	100.0	~~112.1~~ 111.5	119.5	132.2	139.4	145.0	151.3	158.1	170.6	187.3	198.7	209.4	218.7	
Hours worked per year	100.0	99.5	99.3	98.9	~~95.9~~ 133.8	94.4	92.8	89.8	84.8	80.6	80.3	80.7	81.3	
Man-hours	100.0	110.9	118.7	130.7	133.7	136.9	140.4	142.0	144.7	151.0	159.6	169.0	177.8	

USSR: Employment and Indexes of Labor Services in Industry, by Branch
Selected Years, 1950-65
(Continued)

Branch	1950	1952	1953	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
Construction materials														
Employment (thousand wageworkers)														
Reported	547	649	720	830	838	952	1,072	1,162	1,310	1,375	1,383	1,364	1,365	
Estimated industrial cooperative component	20	23	24	25	17	14	17	18	---	---	---	---	---	
Adjusted	567	672	744	855	855	966	1,089	1,180	1,310	1,375	1,383	1,364	1,365	
Indexes of labor services (1950 = 100)														
Adjusted employment	100.0	118.5	131.2	150.8	150.8	170.4	192.1	208.1	231.0	242.5	243.9	240.6	240.7	
Hours worked per year	100.0	99.5	99.3	98.9	95.9	94.4	92.8	89.8	84.8	80.6	80.3	80.7	81.3	
Man-hours	100.0	117.9	130.3	149.1	144.6	160.9	178.3	186.9	195.9	195.5	195.9	194.2	195.7	
Light														
Employment (thousand wageworkers)														
Reported	1,678	1,885	1,975	2,158	2,385	2,467	2,515	2,579	3,371	3,472	3,544	3,550	3,648	
Estimated industrial cooperative component	589	680	729	758	495	405	495	540	---	---	---	---	---	
Adjusted	2,267	2,565	2,704	2,916	2,880	2,872	3,010	3,119	3,371	3,472	3,544	3,550	3,648	
Indexes of labor services (1950 = 100)														
Adjusted employment	100.0	113.1	119.3	128.6	127.0	126.7	132.8	137.6	148.7	153.2	156.3	156.6	160.6	
Hours worked per year	100.0	99.5	99.3	98.9	96.0	94.4	93.6	93.0	87.1	80.5	80.2	80.6	81.2	
Man-hours	100.0	112.5	118.5	127.2	121.9	119.6	124.3	128.0	129.5	123.3	125.4	126.2	130.6	
Food														
Employment (thousand wageworkers)														

USSR: Employment and Indexes of Labor Services in Industry, by Branch
Selected Years, 1950-65
(Continued)

Branch	1950	1952	1953	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964
Reported	1,232	1,332	1,398	1,478	1,579	1,645	1,662	1,688	1,743	1,827	1,844	1,919	1,975
Estimated industrial cooperative component	88	102	109	114	74	61	74	81	---	---	---	---	---
Adjusted	1,320	1,434	1,507	1,592	1,653	1,706	1,736	1,769	1,743	1,827	1,844	1,919	1,975
Indexes of labor services (1950 = 100)													
Adjusted employment	100.0	108.6	114.2	120.6	125.2	129.2	131.5	134.0	132.0	138.4	139.7	145.4	149.6
Hours worked per year	100.0	99.5	99.3	98.9	96.0	94.5	93.7	93.2	87.3	80.5	80.2	80.6	81.2
Man-hours	100.0	108.1	113.4	119.3	120.2	122.1	123.2	124.9	115.2	111.4	112.0	117.2	121.5
Chemicals													
Employment (thousand wageworkers)													
Reported	326	(373)	404	452	(469)	(478)	494	(521)	584	(621)	705	800	870
Estimated industrial cooperative component	39	45	49	51	33	27	33	36	---	---	---	---	---
Adjusted	365	418	453	503	502	505	527	557	584	(621)	705	800	870
Indexes of labor services (1950 = 100)													
Adjusted employment	100.0	114.5	124.1	137.8	137.5	138.4	144.4	152.6	160.0	170.1	193.2	219.2	238.1
Hours worked per year	100.0	99.5	99.3	98.9	95.9	94.3	88.5	82.4	81.6	80.8	80.5	80.9	81.5
Man-hours	100.0	113.9	123.2	136.3	131.9	130.5	127.8	125.7	130.6	137.4	155.5	177.3	194.3
Forest products													
Indexes of labor services (1950 = 100)													
Estimated employment	100.0	103.1	N.A.	107.4	104.4	101.7	99.7	99.3	93.5	93.3	93.3	94.6	94.7
Hours worked per year	100.0	99.5	99.3	98.9	97.5	96.6	94.1	92.6	88.9	82.2	82.0	82.3	82.9
Man-hours	100.0	102.6	N.A.	106.2	101.8	98.2	93.8	92.0	83.1	76.7	76.5	77.9	78.5

a. Wageworkers are the rabochiye in Soviet terminology, and the wage and salary workers involved in the production process are industrial-production personnel (promyshlenno-proizvodstvennyy personal).

Plan available.

Thus the labor inputs indexes available to this paper are imperfect measures of the changes in either employment or man-hours worked. To improve the indexes, more would have to be known about the share in branch output accounted for by workers classified outside the branch and the changes in these proportions over time. Also, it would be desirable to have better information on changes in branch classification and the precise timing of changes both in the length of the scheduled workweek and in hours actually worked.

~~B.~~ 2. Derivation of Employment Indexes

The indexes of both employment (or labor force) and man-hours used in the calculation of factor productivity trends are set forth in Table 7*. In this section the nature of the employment indexes is discussed. Where absolute employment data appear, they are based first of all on published Soviet sources.[34] The forest products index represents a weighted average of employment series for timber, woodworking, and paper derived from labor productivity and official output data using as weights the absolute employment figures for 1958. For some years, employment in the chemical and construction materials has been interpolated using labor productivity and output data. This was also necessary for the petroleum products and natural gas branch in 1964.[35] It should be noted that the labor productivity series appear to be based on a somewhat different concept of average annual employment. Thus the classification is expanded to include workers in producer cooperatives in employment equivalents (measured in terms of work participation rather than membership).

Because the reported employment data do not include workers in producers

* P. 42a, below.

cooperatives before 1960, Table 9 shows for all industry and some branches an adjustment to cover these excluded workers. Total employment of workers in industrial producer cooperatives has been estimated by Murray Weitzman and Andrew Elias for 1950-58.[36] Their procedure has been extended to estimate the number of workers in this category in 1959.

It was announced that 500,000 workers and employees were transferred from industrial cooperatives into state industry in 1956 and 1.2 million in 1960. In 1960, of the total, 1 million wageworkers were transferred as part of the liquidation of the industrial cooperatives, including 600,000 into light industry and 100,000 into machine building and metalworking. Of the remainder it is estimated that 120,000 went into state logging enterprises, 90,000 into the food industry, 40,000 into chemicals, and 20,000 into construction materials.[37] The planned distribution of GVO in industrial cooperatives in 1954 was almost precisely the same as the employment distribution in 1960.[38] As the best approximation available, the percentage distribution in 1960 is applied to the other years before 1960. The light and MBMW branches are the only ones likely to be affected materially by any inaccuracies in these estimates.

3. c. Conversion of Employment Indexes to Indexes of Man-Hours Worked

Since 1950, hours worked in industry have increased less rapidly because of two factors -- a steady reduction in the number of days worked per year and a reduction in the length of the workday after 1955. Both of these trends are represented in the index of hours worked per year as shown in Table 7. Mainly as a result of more generous allowances for holidays and vacation, actual days worked

per year were pared by about 4 percent between 1950 and 1964.[39] Because there is no information available by branch, the trend in days worked per year in industry as a whole is assumed to hold for the branches as well. By far the more important cause of the fall in hours worked in recent years, however, has been the average transfer to a basic 7-hour day together with additional time off before holidays. Before 1956, the Soviet industrial worker put in an 8-hour day; after 1960, he worked a 7-hour day with six hours on Saturday.

The average length of the scheduled workday for adult workers in Soviet industry and in several industrial branches has been reported for mid-1956, the beginning of 1959, the end of 1959, the end of 1960, and the end of March, 1961. Since that time the reported length of the workday has remained unchanged.[40] In estimating the average annual length of the workday, the following procedure has been used:

1. The actual workday is assumed to be equal in length to the workday.

2. The annual average is taken to be equal to the average length of the workday at midyear. The mid-1959 and mid-1960 estimates are averages of the reported figures for end-of-year 1958, 1959, and 1960.

3. There is a gap in the reported data between the end of 1956 and the end of 1958. Midyear estimates have been interpolated for 1957 and 1958 on the basis of Soviet discussions of the progress of reduction in the length of the workweek.[41] For the years before 1956, it seems legitimate to use the reported figure for mid-1956 for the average length of the workday.

4. Over and above the effect of the shorter workday, the average length of the workweek was shortened in March 1956 by the reduction of preholiday workdays to 6 hours. It is reported that the net effect of this reduction was to cut the length of the average workday by 0.26 hour.[42] Therefore, the average length of the workday for industry and all branches has been reduced by 0.20 hour in 1956 and 0.26 hour thereafter.

The indexes of average length of the workday, adjusted for preholiday reduction of hours, can be derived as explained above for industry and for all of the branches of industry covered in this paper except two. For construction materials the index of the length of the workweek in machine building and metalworking is used because the only information on the progress of reduction of hours in this branch (in production of cement and reinforced concrete) approximated the time-table for machine building and metalworking. The index for the forest products industry is especially tentative. It is assumed that the reduction of hours took place somewhat more slowly than in the paper industry (its smallest component), with most of the changeover occurring in 1960-61. How the reduction of hours was carried out in a seasonal industry like logging is not known.

4. D. Summary

No exaggerated claims are made concerning the validity of either the employment or the man-hours indexes discussed above. The man-hours indexes for 1957-59 are not grounded as solidly as could be wished, and the possible effect of this on the data should be kept in mind when comparing factor productivity increases of various periods. In addition, the employment data are particularly sensitive to

undetected changes in coverage. As discussed above, members of producer cooperatives have been added periodically. Moreover, it is not certain that the Soviet authorities have consistently revised reported employment figures for earlier years when some branch components have been reclassified under other branches. The most important example of such a change in recent years was the transfer of the coke-chemical industry, refractory materials, and some other activities into ferrous metals.

Appendix C

Derivation of Indexes of Capital Services

1. Description of Indexes

Although an estimate of the services of both fixed and working capital would be desirable in the calculation of factor productivity, the lack of data on working capital in constant prices precludes the construction of an accurate series for the various branches of industry. The fixed capital itself excludes "unproductive" capital as the Soviet authorities define it -- that is, capital in communal housing, social-cultural services, and subsidiary agricultural activities. Increases in "unproductive" capital conceivably could raise output and productivity by improving the morale of the work force, but such increases would not affect inputs as used in this paper.

Like the labor input series, the data on fixed capital by branch are on an enterprise basis or are classified on the basis of the primary product of the enterprise.[43] Adopting the assumption that indexes of capital services can be approximated by indexes of average annual gross fixed capital stock, this paper relies heavily on official Soviet data. The index of first-of-year capital stock for all industry is the official Soviet capital stock index; the indexes for the nine branches of industry are provided by Soviet sources for 1953, 1955, and 1958-62. No index numbers are reported for 1950, 1954, or 1956-57, or 1963-64; and therefore, they must be estimated from other sources of information on capital →

stock. The index of annual capital services for all industry and for the branches are then constructed by averaging end-of-year indexes.

The officially reported branch indexes of capital stock have been supplemented in two main respects. For the missing years, officially reported branch distributions of capital stock were used to fill out the series. Although the index for industry is a constant cost index, the branch distributions of capital stock given for 1950, 1953, and 1954 are in terms of book value or original cost. The revaluation reduced the value of the productive capital stock in industry by 2 percent compared with the original cost valuation, but the value of individual branches changed in varying amounts depending on the branch structure of productive assets. Because investment costs were higher in 1949-55 than before 1949 or after 1955, those branches which acquired a large part of their capital stock between 1949 and 1954 would tend to have a higher value of capital in original cost prices than in 1955 replacement prices. On the other hand, because pre-1949 investment costs were appreciably lower than 1955 replacement prices, those branches with relatively old asset structures tended to have lower values of capital stock in original cost prices than in 1955 prices. Thus for those branches with relatively ancient asset structures the growth of capital inputs is understated in 1950-53, and the growth of factor productivity is overstated.

The second respect in which the officially reported branch indexes were supplemented concerns the fuel industries. Lacking official indexes for the coal and petroleum and natural gas branches, special estimates had to be constructed as described below.

2.

~~B.~~ Derivation of Indexes of Capital Stock

The first of year and average annual indexes are presented in Table 8.* Indexes of end-of-year values for industry as a whole for all years and for all branches except coal and petroleum products and natural gas for 1953, 1955, and 1959-62 are reported in various statistical handbooks.[44]

The first of year indexes of capital stock in these branches for the remaining years are estimated as follows:

(1) Jan. 1, 1950 -- It is assumed that the branch distribution of capital stock at the beginning of 1950 was the same as at the end of 1950. Therefore the percentage growth in each branch during 1950 is equal to the percentage growth in all industry.

(2) Jan. 1, 1954 -- The growth in each branch between Jan. 1, 1951, and Jan. 1, 1954 is estimated as equal to the percentage growth in all industrial fixed capital (in comparable prices) multiplied by the ratio of the branch share of industrial fixed capital on Jan. 1, 1954, to the branch share on Jan. 1, 1951. These shares are based on original cost valuations.[45]

(3) Jan. 1, 1952, and Jan. 1, 1953 -- For each branch the growth between Jan. 1, 1951, and Jan. 1, 1954 is interpolated based on the relative change in total industrial fixed capital.

(4) Jan. 1, 1955 -- The same procedure as that used for Jan. 1, 1954 is applied (See (2), above).

(5) Jan. 1, 1957 and Jan. 1, 1958 -- Index numbers for these years are interpolated on the basis of capital stock indexes for Jan. 1, 1956, Jan. 1, 1957,

* P. 50a, below.

Table 8

USSR: Indexes of Capital Stock in Industry, by Branch, 1950-65
~~Selected Years~~, ~~1949-65~~

1950 = 100

	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
Industry																	
As of 1 January a/		100.0	111.5	123.8	137.7	152.3	170.0	190.8	213.1	234.6	263.8	290.8	327.7	363.8	402.3	450.8	495.4
Average annual		100.0	111.2	123.6	137.1	152.4	170.6	191.0	211.7	235.6	262.2	292.4	327.0	362.2	403.4	447.4	491.0
			111.3														
Ferrous metals																	
As of 1 January b/		100.0	111.5	123.8	137.7	152.3	166.9	182.8	206.4	231.8	252.8	280.2	321.4	354.8	392.9	440.4	488.7
Average annual		100.0	111.2	123.6	137.1	150.9	165.3	184.0	207.2	229.1	252.0	284.4	320.0	353.5	394.0	436.9	
			111.3										319.1				
Coal																	
As of 1 January c/		100.0	111.5	123.8	135.2	156.6	173.9	190.8	211.1	235.2	261.8	(285.4)	304.2	320.4	337.0	355.6	374.8
Average annual		100.0	111.2	122.4	138.0	156.3	172.4	190.0	211.0	235.0	258.7	278.8	295.3	310.8	327.5	346.8	
			111.3	122.5													
Petroleum products and natural gas																	
As of 1 January d/		100.0	111.5	128.4	147.9	170.5	203.4	236.3	266.5	300.3	341.7	384.5	417.4	454.9	496.3	542.4	591.0
Average annual		100.0	113.4	130.6	150.5	176.8	207.9	237.7	268.0	303.5	343.4	379.1	412.4	449.7	491.1	537.8	
Machine building and metalworking																	
As of 1 January b/		100.0	111.5	120.6	130.5	141.3	151.5	162.5	176.6	190.6	203.5	221.8	241.6	268.5	301.0	330.8	360.0
Average annual		100.0	109.7	118.7	128.5	138.4	148.5	160.3	173.6	186.3	201.1	219.1	241.2	269.3	298.7	328.0	
Construction materials																	
As of 1 January b/		100.0	111.5	130.4	152.5	178.3	208.3	244.3	317.1	402.4	497.5	600.9	729.2	841.6	946.8	1045.3	1148.5
Average annual		100.0	114.4	133.8	156.4	182.8	214.0	265.4	340.2	425.5	519.3	628.9	742.7	845.6	941.9	1037.2	
																1047.3	

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USSR: Indexes of Capital Stock in Industry, by Branch, 1950-65
Selected ~~Years, 1949-65~~
(Continued)

1950 = 100

	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
Light industry																	
As of 1 January b/		100.0	111.5	120.1	129.3	139.4	151.8	165.9	176.7	184.6	203.5	224.4	248.1	267.6	288.6	316.0	336.3
Average annual		100.0	109.5	117.9	127.0	137.7	150.2	162.0	170.8	183.5	202.3	223.4	243.8	263.0	285.9	321.2	
Food industry																	
As of 1 January b/		100.0	111.5	120.0	129.1	138.9	147.9	157.0	172.2	192.5	218.1	241.7	269.5	295.9	320.9	355.9	386.4
Average annual		100.0	109.45	117.8	126.7	135.6	144.2	155.67	172.4	194.1	217.4	241.7	267.3	291.6	320.0	351.0	
Chemicals																	
As of 1 January b/		100.0	111.5	122.2	133.9	146.7	164.9	184.8	214.0	237.1	267.0	312.5	365.3	418.1	501.7	631.6	680.8
Average annual		100.0	110.5	121.1	132.7	147.3	165.3	188.6	213.3	238.3	274.0	320.5	370.4	434.9	535.8	620.5	
Forest products																	
As of 1 January b/		100.0	111.5	123.8	137.7	152.3	163.1	175.1	200.0	211.5	223.9	242.2	269.6	292.4	313.7	344.8	373.0
Average annual		100.0	111.73	123.6	137.1	149.1	~~160.0~~ 159.9	177.4	194.6	205.9	220.4	242.0	265.7	286.6	311.3	339.4	

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Jan. 1, 1958, and Jan. 1, 1959. These indexes in turn are derived from output-capital ratios and indexes of GVO.[476] Each of these indexes in turn was adjusted to make the total growth from Jan. 1, 1956 to Jan. 1, 1959 conform to the growth reported in "Promyshlennost' SSSR."[477] Only for construction materials does the correction factor for annual growth amount to more than 2 percent.

(6) Jan. 1, 1964 and Jan. 1, 1965 -- The growth in fixed capital in each branch compared to Jan. 1, 1963 is estimated from the growth in all industrial fixed capital and the change in branch shares.[478]

The estimation of capital stock indexes for the coal and petroleum products and natural gas branches must be carried out separately because the Soviets publish only an index for all fuels. It is first assumed that the share of the coal branch in total industrial capital stock did not change during 1950 and 1951. Therefore the index of capital stock in the coal industry for Jan. 1, 1951 and Jan. 1, 1952 is the same as that for all industry. This assumption is fairly plausible; the share of the coal industry in total industrial capital (in comparable prices) did not change between Jan. 1, 1952 and Jan. 1, 1959.

The index of growth in capital stock from Jan. 1, 1952 to Jan. 1, 1959 has been reported in comparable prices for the Ministry of the Coal Industry.[479] As the (predominant) share in total production of the enterprises covered by this index did not change much over the period, it used as if it were an index for the coal industry as a whole. The growth in capital stock during 1959 is estimated at 9 percent based on a comparison of the previous growth in capital stock and investment.

Between Jan. 1, 1960 and Jan. 1, 1965 capital stock in the coal industry increased by 32.4 percent. The total increase was 2.28 billion rubles and total investments less change in unfinished construction was 4.974 billion rubles.[50] Using the ratio of change in capital stock to investment (.458), values for capital stock were interpolated for the intervening years.

For petroleum products and natural gas it is assumed that the rate of growth in capital stock equaled that for all industry during 1950.. From Jan. 1, 1951 to Jan. 1, 1954, growth in capital stock is estimated by multiplying the index of growth in total capital stock by the ratio of the branch shares of industrial fixed capital (at original cost) on Jan. 1, 1954 and Jan. 1, 1951.[51] The indexes for intervening years are interpolated.

The growth in capital stock in the petroleum products and natural gas sector after Jan. 1, 1954 is estimated as follows. The Soviets have reported absolute values of capital stock for this branch as well as for all fuels on Jan. 1, 1960 and Jan. 1, 1965.[52] The absolute value of capital stock for all fuels can be computed for Jan. 1, 1954, Jan. 1, 1956, and for the beginning of the years 1959-65.[53] The value of capital stock in the coal industry has been estimated for Jan. 1, 1954 and Jan. 1, 1956. The values of capital stock in other fuels (excluding coal, oil, and gas) can be estimated at .49 and .72 billion rubles, based on the trend in the share of these other fuels in the capital stock of all fuels (at original cost). Therefore, the values of capital stock for petroleum products and natural gas for Jan. 1, 1954 and Jan. 1, 1956 can be estimated by subtraction.

Given benchmark values for capital stock in petroleum products and natural gas on Jan. 1, 1954, Jan. 1, 1956, Jan. 1, 1960, and Jan. 1, 1965:

(1) the value for Jan. 1, 1955 is estimated as an average of the values for Jan. 1, 1954, and Jan. 1, 1956.

(2) the values between Jan. 1, 1956 and Jan. 1, 1960 and between Jan. 1, 1960 and Jan. 1, 1965 were interpolated based on the relation of investment less the change in unfinished construction to the change in capital stock, as was done for the coal industry. During 1956-59 the apparent ratio in the change in capital stock to the investment less the change in unfinished construction was .555; the comparable ratio during 1960-64 was .452.[541/121]

The primary reasons for low increment ratios in fuels are ~~as follows~~: (1) exploratory drilling costs in oil that yield dry wells are included in investment totals but do not appear as capital stock, (2) producing wells that result from exploratory drilling are entered as capital stock but at costs less than the actual drilling costs of the wells, and (3) the value of additions to capital stock is less than the value of investments because of retirements of fixed assets and increments in the stock of unfinished construction.

The average annual indexes of fixed capital stock for industry and for the nine branches of industry presented in Table 8 are calculated by averaging the beginning and end of year indexes. These average annual indexes are then used in the estimation of the growth in combined inputs of labor and capital and the trends in factor productivity.

USSR: Estimated Indexes of Output, Capital Stock, Labor Services, Weighted Inputs, Factor Productivity, Labor Productivity and Capital Productivity in Industry, by Branch
Selected Years, 1950-65

Industry (20 percent discount of growth in MBMW GUO) 1950 = 100

	1953	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
Index of output	137.5	170.3	186.4	203.5	223.4	246.2	265.3	286.2	309.6	331.1	353.6	379.2
Index of capital stock (average annual)	137.1	170.6	191.0	211.7	235.6	262.2	292.4	327.0	362.0	403.4	447.4	491.0
Index of labor services												
Man-hours	116.3	125.1	125.4	125.8	127.8	128.7	128.1	127.4	131.2	135.5	140.9	(147.0)
Adjusted employment	117.1	126.5	130.6	133.7	139.2	144.0	151.1	159.1	164.2	168.9	174.4	181.9
Indexes of weighted inputs, geometric function												
Man-hours												
8 percent interest rate, 1950 weights	120.2	133.1	136.4	139.6	144.4	148.4	151.1	153.8	160.7	168.5	177.5	187.1
8 percent interest rate, 1960 weights	121.8	136.5	141.1	145.5	151.7	157.1	161.4	165.9	174.3	183.9	194.7	206.0
13 percent interest rate, 1960 weights	123.4	139.9	145.9	151.7	159.3	166.3	172.4	178.9	189.1	200.7	213.6	226.9
Employment												
8 percent interest rate, 1960 weights	122.4	137.5	145.3	152.1	161.3	170.3	181.8	194.7	204.9	215.5	227.0	240.2
Indexes of factor productivity												
Man-hours												
8 percent interest rate, 1950 weights	114.4	127.9	136.7	145.8	154.7	165.9	175.6	186.1	192.7	196.5	199.2	202.7
8 percent interest rate, 1960 weights	112.9	124.8	132.1	139.9	147.3	156.7	164.4	172.5	177.6	180.0	181.6	184.1
13 percent interest rate, 1960 weights	111.4	121.7	127.8	134.1	140.2	148.0	153.9	160.0	163.7	165.0	165.5	167.1
Employment												
8 percent interest rate, 1960 weights	112.3	123.9	128.3	133.8	138.5	144.6	145.9	147.0	151.1	153.6	155.8	157.9
Indexes of labor productivity (Man-hours / Employment)	118.2	136.1	148.6	161.8	174.8	191.3	207.1	224.6	236.0	244.4	251.0	258.0
Numbers	100.3	99.8	97.6	96.1	94.8	93.9	90.7	87.5	85.5	82.1	79.0	77.2
Index of capital productivity												

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Table 9

USSR: Estimated Indexes of Output, Capital Stock, Labor Services, Weighted Inputs, Factor Productivity, Labor Productivity and Capital Productivity in Industry, by Branch Selected Years, 1950-65

Industry (10 percent discount of growth in MBMW GNO)

1950 = 100

	1953	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
Index of output	138.7	172.9	189.9	208.0	229.1	253.5	274.1	297.0	322.7	346.7	371.5	399.5
Index of capital stock (average annual)	137.1	170.6	191.0	211.7	235.6	262.2	292.4	327.0	362.0	403.4	447.4	490.0
Index of labor services												
Man-hours	116.3	125.1	125.4	125.8	127.8	128.7	128.1	127.4	131.2	135.5	140.9	(142.0
Adjusted employment	117.1	126.5	130.6	133.7	139.2	144.0	151.1	159.1	164.2	168.9	174.4	180.9
Indexes of weighted inputs, geometric function												
Man-hours												
8 percent interest rate, 1950 weights	120.2	133.1	136.4	139.6	144.4	148.4	151.1	153.8	160.7	168.5	177.5	188.1
8 percent interest rate, 1960 weights	121.8	136.5	141.1	145.5	151.7	157.1	161.4	165.9	174.3	183.9	194.7	206.0
13 percent interest rate, 1960 weights	123.4	139.9	145.9	151.7	159.3	166.3	172.4	178.9	189.1	200.7	213.6	226.9
Employment												
8 percent interest rate, 1960 weights	122.4	137.5	145.3	152.1	161.3	170.3	181.8	194.7	204.9	215.5	227.0	240.2
Indexes of factor productivity												
Man-hours												
8 percent interest rate, 1950 weights	115.4	129.9	139.2	149.0	158.7	170.8	181.4	193.1	200.8	205.8	209.3	213.5
8 percent interest rate, 1960 weights	113.9	126.7	134.6	143.0	151.0	161.4	169.8	179.0	185.1	188.5	190.8	193.9
13 percent interest rate, 1960 weights	112.4	123.6	130.2	137.1	143.8	152.4	159.0	166.0	170.6	172.7	173.9	176.1
Employment												
8 percent interest rate, 1960 weights	113.3	125.7	130.7	136.8	142.0	148.9	150.8	152.5	157.5	160.9	163.7	166.3
Indexes of labor productivity (Man-hours)	119.3	138.2	151.4	165.3	179.3	197.0	214.0	233.1	246.0	255.9	263.7	271.8
~~Man-hours~~ (Employment)	118.4	136.7	145.4	155.6	164.6	176.0	181.4	186.7	196.5	205.3	213.0	219.6
Index of capital productivity	101.2	101.3	99.4	98.3	97.2	96.7	93.7	90.8	89.1	85.9	83.0	81.4

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Table 9

USSR: Estimated Indexes of Output, Capital Stock, Labor Services, Weighted Inputs, Factor Productivity, Labor Productivity and Capital Productivity in Industry, by Branch
Selected Years, 1950-65

Industry (30 percent discount of growth in MBMW GVO)

1950 = 100

	1953	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
Index of output	136.1	167.2	182.4	198.5	217.1	238.3	255.8	274.8	295.9	315.2	335.6	358.8
Index of capital stock (average annual)	137.1	170.6	191.0	211.7	235.6	262.2	292.4	327.0	362.0	403.4	447.4	491.0
Index of labor services												
Man-hours	116.3	125.1	125.4	125.8	127.8	128.7	128.1	127.4	131.2	135.5	140.9	(147.0
Adjusted employment	117.1	126.5	130.6	133.7	139.2	144.0	151.1	159.1	164.2	168.9	174.4	181.9
Indexes of weighted inputs, geometric function												
Man-hours												
8 percent interest rate, 1950 weights	120.2	133.1	136.4	139.6	144.4	148.4	151.1	153.8	160.7	168.5	177.5	187.1
8 percent interest rate, 1960 weights	121.8	136.5	141.1	145.5	151.7	157.1	161.4	165.9	174.3	183.9	194.7	206.0
13 percent interest rate, 1960 weights	123.4	139.9	145.9	151.7	159.3	166.3	172.4	178.9	189.1	200.7	213.6	226.9
Employment												
8 percent interest rate, 1960 weights	122.4	137.5	145.3	152.1	161.3	170.3	181.8	194.7	204.9	215.5	227.0	240.2
Indexes of factor productivity												
Man-hours												
8 percent interest rate, 1950 weights	113.2	125.6	133.7	142.2	150.3	160.6	169.3	178.7	184.1	187.1	189.1	191.8
8 percent interest rate, 1960 weights	111.7	122.5	129.3	136.4	143.1	151.7	158.5	165.6	169.8	171.4	172.4	174.2
13 percent interest rate, 1960 weights	110.3	119.5	125.0	130.8	136.3	143.3	148.4	153.6	156.5	157.0	157.1	158.1
Employment												
8 percent interest rate, 1960 weights	111.2	121.6	125.5	130.5	134.6	139.9	140.7	141.1	144.4	146.3	147.8	149.4
Indexes of labor productivity (Man-hours)	117.0	133.7	145.5	157.8	169.9	185.2	199.7	215.7	225.5	232.6	238.2	244.1
(Employment)	116.2	132.2	139.7	148.5	156.0	165.5	169.3	172.7	180.2	186.6	192.4	197.3
Index of capital productivity	99.3	98.0	95.5	93.8	92.1	90.9	87.5	84.0	81.7	78.1	75.0	73.1

Table

USSR: Estimated Indexes of Output, Capital Stock, Labor Services, Weighted Inputs, Factor Productivity, Labor Productivity and Capital Productivity in Industry, by Branch Selected Years, 1950-64

Ferrous metals

1950 = 100

	1953	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
Index of output	143.1	175.0	189.7	201.1	216.0	236.8	257.5	278.4	300.8	319.5	345.2	
Index of capital stock (average annual)	137.1	165.3	184.0	207.2	229.1	252.0	284.4	316.6	353.5	394.0	436.9	
Index of labor services												
Man-hours	116.1	121.4	119.3	115.9	114.8	113.9	119.4	122.4	125.3	130.0	135.0	
Adjusted employment	116.9	122.8	124.3	126.5	134.4	139.2	146.7	152.8	156.8	162.1	167.1	
Indexes of weighted inputs, geometric function												
Man-hours												
8 percent interest rate, 1950 weights	121.4	132.0	134.1	135.6	138.3	141.1	150.9	158.6	165.8	175.4	185.4	
8 percent interest rate, 1960 weights	123.7	136.5	140.7	144.5	149.3	154.0	166.0	176.3	185.8	198.1	210.9	
13 percent interest rate, 1960 weights	125.3	139.9	145.6	151.4	157.8	164.1	178.0	190.4	201.9	216.5	231.7	
Employment												
8 percent interest rate, 1960 weights	124.2	137.5	144.3	152.6	164.6	174.4	188.7	202.3	213.6	227.2	240.8	
Indexes of factor productivity												
Man-hours												
8 percent interest rate, 1950 weights	117.9	132.6	141.5	148.3	156.2	167.8	170.6	175.5	181.4	182.2	186.2	
8 percent interest rate, 1960 weights	115.7	128.2	134.8	139.2	144.7	153.8	155.1	157.9	161.9	161.3	163.7	
13 percent interest rate, 1960 weights	114.2	125.1	130.3	132.8	136.9	144.3	144.7	146.2	149.0	147.6	149.0	
Employment												
8 percent interest rate, 1960 weights	115.2	127.3	131.5	131.8	131.2	135.8	136.5	137.6	140.8	140.6	143.4	
Indexes of labor productivity — Man-hours	123.3	144.2	159.0	173.5	188.2	207.9	215.7	227.5	240.1	245.8	255.7	
— Employment	122.4	142.5	152.6	159.0	160.7	170.1	175.5	182.2	191.8	197.1	206.6	
Index of capital productivity	104.4	105.9	103.1	97.1	94.3	94.0	90.5	87.1	85.1	81.1	79.0	

Table

USSR: Estimated Indexes of Output, Capital Stock, Labor Services, Weighted Inputs, Factor Productivity, Labor Productivity and Capital Productivity in Industry, by Branch Selected Years, 1950-64

Coal

1950 = 100

	1953	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
Index of output	122.0	149.7	164.1	177.0	189.8	195.2	199.6	199.7	203.6	209.6	218.0	
Index of capital stock (average annual)	138.0	172.4	190.0	211.0	235.0	258.7	278.8	295.3	310.8	327.5	346.8	
Index of labor services												
Man-hours	107.5	121.2	126.9	127.6	125.2	117.4	106.3	99.7	98.4	97.8	98.8	
Adjusted employment	108.3	122.5	132.2	139.5	146.3	146.7	140.8	137.3	136.1	134.7	135.0	
Indexes of weighted inputs, geometric function												
Man-hours												
8 percent interest rate, 1950 weights	113.3	130.5	138.1	141.8	142.9	138.6	130.2	125.2	125.3	126.1	128.6	
8 percent interest rate, 1960 weights	115.6	134.2	142.7	147.6	150.3	147.6	140.6	136.6	137.4	138.9	142.2	
13 percent interest rate, 1960 weights	117.3	137.1	146.2	152.2	156.1	154.8	149.0	145.8	147.2	149.3	153.3	
Employment												
8 percent interest rate, 1960 weights	116.2	135.3	146.9	157.3	167.9	172.9	171.6	171.4	172.9	174.3	177.5	
Indexes of factor productivity												
Man-hours												
8 percent interest rate, 1950 weights	107.7	114.7	118.8	124.8	132.8	140.8	153.3	159.5	162.5	166.2	169.5	
8 percent interest rate, 1960 weights	105.5	111.5	115.0	119.9	126.3	132.2	142.0	146.2	148.2	150.9	153.3	
13 percent interest rate, 1960 weights	104.0	109.2	112.2	116.3	121.6	126.1	134.0	137.0	138.3	140.4	142.2	
Employment												
8 percent interest rate, 1960 weights	105.0	110.6	111.7	112.5	113.0	112.9	116.3	116.5	117.8	120.3	122.8	
Indexes of labor productivity - Man-hours	113.5	123.5	129.3	138.7	151.6	166.3	187.8	200.3	206.9	214.3	220.6	
- Employment	112.7	122.2	124.1	126.9	129.7	133.1	141.8	145.4	149.6	155.6	161.5	
~~Man-hours~~ Index of capital productivity	88.4	86.8	86.4	83.9	80.8	75.5	71.6	67.6	65.5	64.0	62.9	

Table

USSR: Estimated Indexes of Output, Capital Stock, Labor Services, Weighted Inputs, Factor Productivity, Labor Productivity and Capital Productivity in Industry, by Branch Selected Years, 1950-64

Petroleum products and natural gas

1950 = 100

	1953	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
Index of output	139.6	174.8	208.5	244.9	282.1	323.1	368.0	413.2	469.0	521.1	570.7	
Index of capital stock (average annual)	150.5	207.9	237.7	268.0	303.5	343.4	379.1	412.4	449.7	491.1	537.8	
Index of labor services												
Man-hours	117.7	133.3	132.5	133.4	142.5	140.8	136.3	137.2	134.1	134.8 140.9	137.5	
Adjusted employment	118.5	134.8	138.0	141.3	152.2	155.4	160.9	170.7	167.4	175.0 167.4	169.6	
Indexes of weighted inputs, geometric function												
Man-hours												
8 percent interest rate, 1950 weights	137.1	175.6	190.4	205.6	227.7	244.7	257.0	271.4	283.9	300.5 305.6	320.3	
8 percent interest rate, 1960 weights	142.2	187.7	207.8	228.3	255.1	279.7	299.6	320.2	340.5	364.8	393.0	
13 percent interest rate, 1960 weights	144.0	191.9	214.0	236.4	264.9	292.5	315.3	338.3	361.7	387.2 389.1	420.7	
Employment												
8 percent interest rate, 1960 weights	142.4	188.2	209.8	231.3	258.9	286.2	311.3	336.7	358.3	383.4 387.3	412.4	
Indexes of factor productivity												
Man-hours												
8 percent interest rate, 1950 weights	101.8	99.5	109.5	119.1	123.9	132.0	143.2	153.2	165.2	173.4	178.2	
8 percent interest rate, 1960 weights	98.2	93.1	100.3	107.3	110.6	115.5	122.8	129.0	137.7	142.8	145.2	
13 percent interest rate, 1960 weights	96.9	91.1	97.4	103.6	106.5	110.5	116.7	122.1	129.7	133.9	135.7	
Employment												
8 percent interest rate, 1960 weights	98.0	92.9	99.4	105.9	109.0	112.9	118.2	122.7	130.9	135.9	138.4	
Indexes of labor productivity - Man-hours	118.6	131.1	157.4	183.6	198.0	229.5	270.0	301.2	349.7	386.6	415.1	
- Employment	117.8	129.7	151.1	173.3	185.3	207.9	228.7	242.1	290.2	311.3	336.5	
Man-hours												
Index of capital productivity	92.8	84.1	87.7	91.4	92.9	94.1	97.1	100.2	104.3	106.1	106.1	

Table

USSR: Estimated Indexes of Output, Capital Stock, Labor Services, Weighted Inputs, Factor Productivity, Labor Productivity and Capital Productivity in Industry, by Branch
Selected Years, 1950-64

Machine building and metal working (10 percent discount of growth in GVO)

1950 = 100

	1953	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
Index of output	152.3	~~204.5~~	230.5	257.7	289.5	329.1	372.9	423.2	481.5	538.3	583.8	
Index of capital stock (average annual)	128.5	148.5	160.3	173.6	186.3	201.1	219.1	241.2	269.3	298.7	328.0	
Index of labor services												
Man-hours	118.7	130.7	133.~~8~~	136.9	140.4	142.0	144.7	151.0	159.6	169.0	177.8	
Adjusted employment	119.5	132.2	139.4	145.0	151.3	158.1	170.6	187.3	198.7	209.4	218.7	
Indexes of weighted inputs, geometric function												
Man-hours												
8 percent interest rate, 1950 weights	120.4	133.7	138.~~2~~	142.9	147.7	151.2	155.9	164.3	175.4	187.2	198.5	
8 percent interest rate, 1960 weights	120.5	133.9	138.~~5~~	143.2	148.2	151.7	156.6	165.1	176.3	188.3	199.7	
13 percent interest rate, 1960 weights	121.1	134.9	~~139.9~~ 140.0	145.3	150.7	154.9	160.5	169.8	181.9	194.9	207.2	
Employment												
8 percent interest rate, 1960 weights	121.2	135.2	143.1	150.0	157.4	165.5	178.9	196.5	210.5	224.0	236.2	
Indexes of factor productivity												
Man-hours												
8 percent interest rate, 1950 weights	176.5	153.0	166.8	180.3	196.0	٢17.7	٢39.٢	٢57.6	٢74.5	٢87.6	٢94.1	
8 percent interest rate, 1960 weights	176.4	15٢.7	166.4	180.0	195.3	٢16.9	٢38.1	٢56.3	٢73.1	٢85.9	٢9٢.3	
13 percent interest rate, 1960 weights	175.8	151.6	164.6	177.4	19٢.1	٢1٢.5	٢3٢.3	٢49.٢	٢64.7	٢76.٢	٢81.8	
Employment												
8 percent interest rate, 1960 weights	1٢5.7	151.3	161.1	171.8	183.9	198.9	٢08.4	٢15.4	٢٢8.7	٢40.3	٢47.2	
Indexes of labor productivity - Man-hours / Employment	1٢8.3	156.5	17٢.3	188.٢	٢06.٢	٢31.8	٢57.7	٢80.3	301.7	318.5	328.3	
~~Man-hours~~	1٢7.4	154.7	165.4	177.7	191.3	٢08.٢	٢18.6	٢٢5.9	٢4٢.3	٢57.1	٢66.9	
Index of capital productivity	118.5	137.7	143.8	148.4	155.4	163.6	170.٢	175.5	178.8	180.٢	178.0	

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Table

USSR: Estimated Indexes of Output, Capital Stock, Labor Services, Weighted Inputs, Factor Productivity, Labor Productivity and Capital Productivity in Industry, by Branch
Selected Years, 1950-65

Machine building and metal working (20 percent of growth in GVO)

1950 = 100

	1953	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
Index of output	145.7	189.7	211.1	233.2	258.8	290.3	324.7	363.7	408.2	451.0	484.9	
Index of capital stock (average annual)	128.5	148.5	160.3	173.6	186.3	201.1	219.1	241.2	269.3	298.7	328.0	
Index of labor services												
Man-hours	118.7	130.7	133.8	136.9	140.4	142.0	144.7	151.0	159.6	169.0	177.8	
Adjusted employment	119.5	132.2	139.4	145.0	151.3	158.1	170.6	187.3	198.7	209.4	218.7	
Indexes of weighted inputs, geometric function												
Man-hours												
8 percent interest rate, 1950 weights	120.4	133.7	138.2	142.9	147.7	151.2	155.9	164.3	175.4	187.2	198.5	
8 percent interest rate, 1960 weights	120.5	133.9	138.5	143.2	148.1	151.7	156.6	165.1	176.3	188.3	199.7	
13 percent interest rate, 1960 weights	121.1	134.9	~~139.9~~ 140.0	145.3	150.7	154.9	160.5	169.8	181.9	194.9	207.2	
Employment												
8 percent interest rate, 1960 weights	121.2	135.2	143.1	150.0	157.4	165.5	178.9	196.5	210.5	224.0	236.2	
Indexes of factor productivity												
Man-hours												
8 percent interest rate, 1950 weights	121.0	141.9	151.7	163.1	175.1	191.0	208.3	221.4	231.7	240.9	244.3	
8 percent interest rate, 1960 weights	120.9	141.7	151.4	162.8	174.7	191.4	207.3	220.3	231.5	239.5	242.8	
13 percent interest rate, 1960 weights	120.3	140.6	150.8	160.5	171.7	187.4	207.3	214.1	224.4	231.4	234.0	
Employment												
8 percent interest rate, 1960 weights	120.1	140.3	147.5	155.5	164.4	175.4	181.5	185.1	193.9	201.3	205.3	
Indexes of labor productivity - Man-hours / Employment	122.7	145.1	157.8	170.3	184.3	204.4	224.4	240.9	255.8	266.9	277.7	
~~Man-hours~~	121.9	143.5	151.4	160.8	171.0	183.6	190.3	194.2	205.4	215.4	221.7	
Index of capital productivity	113.4	127.7	131.7	134.3	138.9	144.4	148.2	150.8	151.6	151.0	147.8	

Table

USSR: Estimated Indexes of Output, Capital Stock, Labor Services, Weighted Inputs, Factor Productivity, Labor Productivity and Capital Productivity in Industry, by Branch
Selected Years, 1950-64

Machine building and metal working (30 percent discount of growth in GVO)

1950 = 100

	1953	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
Index of output	139.4	176.0	193.4	211.1	231.3	255.9	282.4	312.1	345.5	377.2	402.0	
Index of capital stock (average annual)	128.5	148.5	160.3	173.6	186.3	201.1	219.1	241.2	269.3	298.7	328.0	
Index of labor services												
Man-hours	118.7	130.7	133.8	136.9	140.4	142.0	144.7	151.0	159.6	169.0	177.8	
Adjusted employment	119.5	132.2	139.4	145.0	151.3	158.1	170.6	187.3	198.7	209.4	218.7	
Indexes of weighted inputs, geometric function												
Man-hours												
8 percent interest rate, 1950 weights	120.4	133.7	138.2	142.9	147.7	151.2	155.9	164.3	175.4	187.2	198.5	
8 percent interest rate, 1960 weights	120.5	133.9	138.5	143.2	148.1	151.7	156.6	165.1	176.3	188.3	199.7	
13 percent interest rate, 1960 weights	121.1	134.9	140.0	145.3	150.7	154.9	160.5	169.8	181.9	194.9	207.2	
Employment												
8 percent interest rate, 1960 weights	121.2	135.2	143.1	150.0	157.4	165.5	178.9	196.5	210.5	224.0	236.2	
Indexes of factor productivity												
Man-hours												
8 percent interest rate, 1950 weights	115.8	131.6	139.9	147.7	156.6	169.2	181.1	190.0	197.0	201.5	202.5	
8 percent interest rate, 1960 weights	115.7	131.4	139.6	147.4	156.2	168.7	180.3	189.0	196.0	200.3	201.3	
13 percent interest rate, 1960 weights	115.1	130.5	138.1	145.3	153.5	165.2	176.0	183.8	189.9	193.5	194.0	
Employment												
8 percent interest rate, 1960 weights	115.0	130.2	135.2	140.7	147.0	154.6	157.9	158.8	164.1	168.4	170.2	
Indexes of labor productivity - Man-hours	117.4	134.7	144.5	154.2	164.7	180.2	195.2	206.7	216.5	222.2	226.1	
Employment	116.7	133.1	138.7	145.6	152.9	161.9	165.5	166.6	173.9	180.1	183.8	
Index of capital productivity	108.5	118.5	120.6	121.6	124.2	127.3	128.9	129.4	128.3	126.3	122.6	

Table

USSR: Estimated Indexes of Output, Capital Stock, Labor Services, Weighted Inputs, Factor Productivity, Labor Productivity and Capital Productivity in Industry, by Branch Selected Years, 1950-64

Construction materials

1950 = 100

	1953	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
Index of output	154.8	~~215.0~~	245.8	296.0	355.2	423.9	489.0	540.5	588.6	622.1	663.4	
Index of capital stock (average annual)	156.4	214.0	265.4	340.2	425.5	519.3	628.9	742.7	845.6	941.9	1037.5	
Index of labor services												
Man-hours	130.3	149.1	144.8	160.9	178.3	186.9	195.9	195.5	195.9	194.2	195.7	
Adjusted employment	131.2	150.8	150.8	170.4	192.1	208.1	231.0	242.5	243.9	240.6	240.7	
Indexes of weighted inputs, geometric function												
Man-hours												
8 percent interest rate, 1950 weights	133.7	156.8	157.6	178.7	201.4	215.6	230.6	235.7	240.4	242.2	247.2	
8 percent interest rate, 1960 weights	136.6	163.8	169.5	195.5	223.5	243.8	265.3	276.6	285.5	292.8	301.9	
13 percent interest rate, 1960 weights	138.4	168.0	176.9	206.0	237.6	261.9	287.9	303.7	317.4	327.0	339.3	
Employment												
8 percent interest rate, 1960 weights	137.3	165.2	174.7	204.0 ~~203.9~~	236.2	264.0 ~~263.9~~	299.7	324.4	337.0	343.1	351.9	
Indexes of factor productivity												
Man-hours												
8 percent interest rate, 1950 weights	115.8	137.1	156.0	165.6	176.4	196.6	212.1	229.3	244.8	256.9	268.4	
8 percent interest rate, 1960 weights	113.3	131.3	145.0	151.4	158.9	173.9	184.3	195.4	206.2	212.5	219.7	
13 percent interest rate, 1960 weights	111.8	128.0	138.9	143.7	149.5	161.9	169.9	178.0	185.4	190.2	195.5	
Employment												
8 percent interest rate, 1960 weights	112.7	130.1	140.7	145.1	150.4	160.6	163.2	166.6	174.7	181.3	188.5	
Indexes of labor productivity - Man-hours	118.8	144.2	169.8	184.0	199.2	226.8	249.6	276.5	300.5	320.3	339.0	
- Employment	118.0	142.6	163.0	173.7	184.9	203.7	211.7	222.9	241.3	258.6	275.6	
~~Man-hours~~												
Index of capital productivity	99.0	100.5	92.6	87.0	83.5	81.6	77.8	72.8	69.6	66.0	64.4	

Table

USSR: Estimated Indexes of Output, Capital Stock, Labor Services, Weighted Inputs, Factor Productivity, Labor Productivity and Capital Productivity in Industry, by Branch Selected Years, 1950-64

Light industry

1950 = 100

	1953	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
Index of output	137.1	162.1	172.9	184.4	199.4	212.9	225.3	232.5	242.1	247.5	257.8	
Index of capital stock (average annual)	127.0	150.2	162.0	170.8	183.5	202.3	223.4	243.8	263.0	285.9	321.2	
Index of labor services												
Man-hours	118.5	127.2	121.9	119.6	124.3	128.0	129.5	123.3	125.4	126.2	130.6	
Adjusted employment	119.3	128.6	127.0	126.7	132.8	137.6	148.7	153.2	156.3	156.6	160.9	
Indexes of weighted inputs, geometric function												
Man-hours												
8 percent interest rate, 1950 weights	119.3	129.3	125.4	123.9	129.2	134.0	136.8	132.0	135.0	137.0	142.9	
8 percent interest rate, 1960 weights	119.4	129.5	125.8	124.4	129.7	134.6	137.5	132.9	136.0	138.1	144.2	
13 percent interest rate, 1960 weights	119.8	130.6	127.6	126.6	132.3	137.7	141.3	137.5	141.2	143.8	150.8	
Employment												
8 percent interest rate, 1960 weights	120.1	130.8	130.4	130.9	137.6	143.6	155.5	161.2	165.5	167.3	173.6	
Indexes of factor productivity												
Man-hours												
8 percent interest rate, 1950 weights	114.9	125.4	137.9	148.8	154.3	158.9	164.7	176.1	179.3	180.7	180.4	
8 percent interest rate, 1960 weights	114.8	125.2	137.4	148.2	153.7	158.2	163.9	174.9	178.0	179.2	178.8	
13 percent interest rate, 1960 weights	114.4	124.1	135.5	145.7	150.7	154.6	159.4	169.1	171.5	172.1	171.0	
Employment												
8 percent interest rate, 1960 weights	114.2	123.9	132.6	140.9	144.9	148.3	144.9	144.2	146.3	147.9	148.5	
Indexes of labor productivity - Man-hours	115.7	127.4	141.8	154.2	160.4	166.3	174.0	188.6	193.1	196.1	197.4	
- Employment	114.9	126.0	136.1	145.5	150.2	154.7	151.5	151.8	154.9	158.0	160.2	
Index of capital productivity	108.0	107.9	106.7	108.0	108.7	105.2	100.9	95.4	92.1	86.6	80.3	

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Table

USSR: Estimated Indexes of Output, Capital Stock, Labor Services, Weighted Inputs, Factor Productivity, Labor Productivity and Capital Productivity in Industry, by Branch
Selected Years, 1950-64

Food industry

1950 = 100

	1953	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
Index of output	138.6	~~157.5~~	173.3	185.5	197.2	214.4	218.3	236.0	249.0	249.4	261.5	
Index of capital stock (average annual)	126.7	144.2	155.8	172.4	194.1	217.4	241.7	267.3	291.6	320.0	351.0	
Index of labor services												
Man-hours	113.4	119.3	120.2	122.1	123.2	124.9	115.2	111.4	112.0	117.2	121.5	
Adjusted employment	114.2	120.6	125.2	129.2	131.5	134.0	132.0	138.4	139.7	145.4	149.6	
Indexes of weighted inputs, geometric function												
Man-hours												
8 percent interest rate, 1950 weights	116.7	125.3	128.6	133.6	138.7	144.3	139.7	139.9	143.6	152.2	160.1	
8 percent interest rate, 1960 weights	117.5	126.8	130.6	136.4	142.5	149.1	146.0	147.4	152.1	161.6	170.6	
13 percent interest rate, 1960 weights	118.7	128.9	133.7	140.7	148.4	156.8	156.1	159.5	165.8	176.9	187.7	
Employment												
8 percent interest rate, 1960 weights	118.1	127.7	134.2	141.7	148.9	156.4	160.2	170.9	176.8	187.2	196.5	
Indexes of factor productivity												
Man-hours												
8 percent interest rate, 1950 weights	118.8	125.7	134.8	138.8	142.2	148.6	156.3	168.7	173.4	163.9	163.3	
8 percent interest rate, 1960 weights	118.0	124.2	132.7	136.0	138.4	143.8	149.5	160.1	163.7	154.3	153.3	
13 percent interest rate, 1960 weights	116.8	122.2	129.6	131.8	132.9	136.7	139.8	148.0	150.2	141.0	139.3	
Employment												
8 percent interest rate, 1960 weights	117.4	123.3	129.1	130.9	132.4	137.1	136.3	138.1	140.8	133.2	133.1	
Indexes of labor productivity - Man-hours	122.2	132.0	144.2	151.9	160.1	171.7	189.5	211.8	222.3	212.8	215.2	
- Employment	121.4	130.6	138.4	143.6	150.0	160.0	165.4	170.5	178.2	171.5	174.8	
~~Man-hours~~												
Index of capital productivity	109.4	109.2	111.3	107.6	101.6	98.6	90.3	88.3	85.4	77.9	74.5	

Table

USSR: Estimated Indexes of Output, Capital Stock, Labor Services, Weighted Inputs, Factor Productivity, Labor Productivity and Capital Productivity in Industry, by Branch
Selected Years, 1950-64

Chemicals

1950 = 100

	1953	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
Index of output	145.9	187.5	205.9	230.4	259.3	289.7	316.3	341.2	371.9	409.3	459.9	
Index of capital stock (average annual)	132.7	165.3	188.6	213.3	238.3	274.0	320.5	370.4	434.9	535.8	620.5	
Index of labor services												
Man-hours	123.2	136.3	131.9	130.5	127.8	125.7	130.6	137.4	155.5	177.3	194.3	
Adjusted employment	124.1	137.8	137.5	138.4	144.4	152.6	160.0	170.1	193.2	219.2	238.4	
Indexes of weighted inputs, geometric function												
Man-hours												
8 percent interest rate, 1950 weights	125.5	143.0	144.2	147.6	149.3	152.7	163.5	176.1	201.1	233.8	259.7	
8 percent interest rate, 1960 weights	126.4	145.8	149.5	155.0	158.9	165.1	178.8	194.4	222.9	261.1	291.7	
13 percent interest rate, 1960 weights	127.2	148.1	153.8	161.2	167.1	175.7	192.1	210.5	242.0	285.3	320.1	
Employment												
8 percent interest rate, 1960 weights	127.0	146.9	153.6	161.0	172.1	187.3	204.0	223.4	256.7	299.7	333.2	
Indexes of factor productivity												
Man-hours												
8 percent interest rate, 1950 weights	116.3	131.1	142.8	156.1	173.7	189.7	193.5	193.8	184.9	175.1	177.1	
8 percent interest rate, 1960 weights	115.4	128.6	137.7	148.6	163.2	175.5	176.9	175.5	166.8	156.8	157.7	
13 percent interest rate, 1960 weights	114.7	126.6	133.9	142.9	155.2	164.9	164.7	162.1	153.7	143.5	143.7	
Employment												
8 percent interest rate, 1960 weights	114.9	127.6	134.0	143.1	150.7	154.7	155.0	152.7	144.9	136.6	138.0	
Indexes of labor productivity - Man-hours	118.4	137.6	156.1	176.6	202.9	230.5	242.2	248.3	239.2	230.9	236.7	
- Employment	117.6	136.1	149.7	166.5	179.6	189.8	197.7	200.6	192.5	186.7	192.9	
Index of capital productivity	109.9	113.4	109.2	108.0	108.8	105.7	98.7	92.1	85.5	76.4	74.1	

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Table 9

USSR: Estimated Indexes of Output, Capital Stock, Labor Services, Weighted Inputs, Factor Productivity, Labor Productivity and Capital Productivity in Industry, by Branch Selected Years, 1950-65

Forest Products

1950 = 100

	1953	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
Index of output	121.8	144.6	150.3	162.2	177.3	196.0	198.6	201.9	210.4	222.2	233.2	
Index of capital stock (average annual)	137.1	159.9	177.4	194.6	205.9	220.4	242.0	265.7	286.6	311.3	339.4	
Index of labor services												
Man-hours	N.A.	146.2	101.8	98.2	93.8	92.0	83.1	76.7	76.5	77.9	78.5	
Adjusted employment	N.A.	107.4	104.4	101.7	99.7	99.3	93.5	93.3	93.3	94.6	94.7	
Indexes of weighted inputs, geometric function												
Man-hours												
8 percent interest rate, 1950 weights		111.5	108.8	106.6	103.1	102.2	94.5	89.0	89.6	92.0	93.6	
8 percent interest rate, 1960 weights		115.3	113.8	112.6	109.8	109.6	102.9	98.3	99.6	102.8	105.2	
13 percent interest rate, 1960 weights		117.6	117.0	116.5	114.2	114.5	108.6	104.6	106.4	110.1	113.2	
Employment												
8 percent interest rate, 1960 weights		116.3	116.1	115.8	115.3	116.5	113.1	115.0	116.8	120.0	122.2	
Indexes of factor productivity												
Man-hours												
8 percent interest rate, 1950 weights		129.7	138.1	152.2	172.0	191.8	210.2	226.9	234.8	241.5	249.1	
8 percent interest rate, 1960 weights		125.4	132.1	144.0	161.5	178.8	193.0	205.4	211.2	216.1	221.7	
13 percent interest rate, 1960 weights		123.0	128.5	139.2	155.3	171.2	182.9	193.0	197.7	201.8	206.0	
Employment												
8 percent interest rate, 1960 weights		124.3	129.5	140.1	153.8	168.2	175.6	175.6	180.1	185.2	190.8	
Indexes of labor productivity (man-hours / employment)		136.2	147.6	165.2	189.0	213.0	239.0	263.2	275.0	285.2	297.1	
~~Man-hours~~		134.6	144.0	159.5	177.8	197.4	212.4	216.4	225.5	234.9	246.3	
Index of capital productivity		90.4	84.7	83.4	86.1	88.9	82.1	76.0	73.4	71.4	68.7	

1. J. W. Kendrick, Productivity Trends in the United States, Princeton, New Jersey, 1961, p. 80-82.

2. Rush V. Greenslade and Phyllis Wallace, "Industrial Production in the U.S.S.R.," Dimensions of Soviet Economic Power, Joint Economic Committee, U.S. Congress, 1962, p. 119-136.

3. A number of attempts have been made to estimate the course of factor productivity in the Soviet economy -- for example, those by Abram Bergson for gross national product (GNP) and by Raymond P. Powell for industrial production. Both studies showed a spectacular growth in factor productivity during 1951-58 compared with earlier periods, but both studies ended with 1958. Since 1958 the growth of Soviet industrial output has slowed considerably. (Abram Bergson, "National Income," and Raymond P. Powell, "Industrial Production," in Economic Trends in the Soviet Union, ed by Abram Bergson and Simon Kuznets, Cambridge, Massachusetts, 1963, p. 1-37 and 150-202.)

4. CIA. CIA/RR ER 63-29, Index of Civilian Industrial Production in the USSR, 1950-61, Sept, 1963.

5. CIA, op. cit., p. 2.

6. The method used to combine the labor and capital indexes is outlined in Appendix A; the indexes of labor inputs are derived in Appendix B, and the indexes of capital stock in Appendix C.

7. These assumed interest rates do not seem to be too high. Under the new reform in industry a charge of 6 percent is to be levied on the undepreciated value of capital stock. L. Kantorovich argues that the "income norm" for capital (not the payment for capital) whould be as high as 20 or 25 percent. (Ekonomicheskaya gazeta, No 45, Nov 1965.) In other East European countries payments for capital stock, which again are not the return on capital, have ranged from 2 to 10 percent. (N. Mitrofana, Planovoye khozyaystvo, No 10, Oct 1965, p. 58-60.)

8. These annual rates of increase were calculated on the assumption that output in MBMW is best approximated by a 20 percent discount of growth in the official GVO index. (See p. 5 above.) Under alternative assumptions of a 10 percent and 30 percent discount, there is the same pattern of decline in growth. With a 10 percent discount the rates of growth of industrial output for 1951-55, 1956-58, 1959-61, and 1962-64 are $11\frac{1}{2}$, $9\frac{1}{2}$, 9, and $7\frac{1}{2}$ percent; with a 30 percent discount of growth in MBMW output, the rates of growth for these periods are $10\frac{1}{2}$, 9, 8, and $6\frac{1}{2}$ percent.

9. More than two-thirds of the reduction of 19 percent in the hours per worker per year was caused by a reduction of 13 percent in the scheduled workweek. The balance of the reduction reflected 5 days additional off on the average for the year (holidays and vacations, 3 additional days a year for maternity and sick leave, and a shorter workday on the days preceding holidays). Part of this reduction in days worked over time also reflects a changing age and sex composition of the industrial labor force.

10. Not only because of the usual conceptual reasons -- changing factor proportions, for example -- but because of a decline in fatigue and because of better morale. Edward Denison puts the question in the following way:

"...Neither an hour's labor nor a year's labor is the same amount of work when a man works 72 hours a week as when he works 48 or 35. As the hours are shortened, the product turned out in an hour usually increases as a direct consequence of the change in hours." In his study of US growth, Denison uses a formula which assumes that marginal reductions of hours to a level of about 49 hours per week cause no loss in output per man. Thereafter, further cuts in the workweek bring increasing proportionate losses in output per man: with a workweek of 40 hours per week, a reduction of 1 percent in the workweek is assumed to cause a reduction of 0.6 percent in output per man. (The Sources of Economic Growth in the United States, Committee for Economic Development, Supplementary Paper No 13, Jan 1962, p. 35, 40.)

11. The arithmetic function used has an infinite elasticity of substitution of one factor for another, while the geometric index has an elasticity of substitution of unity. Thus, a large area of possible "true" factor substitution characteristics is bracketed.

12. The Kendall rank correlation coefficient is .5; the probability of a value this large in the absence of any association between growth in the capital-labor ratios and growth in output-labor ratios is .038.

13. Output and input series were computed by Powell with alternative ruble price weights, and the results differed significantly. The rates of factor productivity increases cited above were based on the use of 1950 prices. Powell, op. cit., p. 172.

14. Nicholas DeWitt, Costs and Returns to Education in the U.S.S.R.," Cambridge, Massachusetts, 1962, p. 136, 273.

15. Including the accumulated costs of educating the person to the highest grade level attained plus the value of output that the economy foregoes by not having him in productive employment during the period of his schooling.

16. In his study of US economic growth, Edward Denison estimated that nearly one-fourth of the total growth in national income during 1929-57 was accounted for by an increase in the average educational attainment of the labor force. (Op. cit., p. 73.)

17. B. N. Mikhalevskiy in Ekonomika i matematicheskiye metody, No 6, 1965, p. 893, estimates that for the USSR the rate of increase in the net value of labor power, weighted by qualifications of the workers, increased by 12.3 percent per year during 1952-59 and 6.8 percent per year during 1960-63.

18. See, for example, the article by M. Kandyba and V. Panasenko in Planovoye khozyaystvo, No 12, Dec 1963, p. 58-62.

19. L. Gatovskiy argues that this is a key factor in stimulating technical progress. (Ekonomicheskaya gazeta, No 48, Dec 1963, p. 5.)

20. V. P. Krasovskiy and A. S. Tolkachev, Struktura kapital'nykh vlozhenyy SSSR i SShA, Moscow, 1965, p. 83.

21. From an average implicit rate of retirement of 4.4 percent in 1956-59 to 2.0 percent in 1960-64. The procedure is to subtract the estimated annual increments in capital stock from annual gross investments adjusted for changes in unfinished construction and then to divide the remainder by the capital stock at the beginning of the year. Although the stock figures are only estimates and the comparability of the investment and stock series is not certain, the major data problem is the lack of a series for unfinished construction before 1958. Thus, gross additions probably are abnormally high. Nevertheless, unfinished contruction would have to have increased at far above the amounts recorded during 1958-64 to prevent an increase in the implicit retirement rate.

22. Based on data on centralized financing of capital repair in the national economy. Values in current prices have been deflated roughly by a cost index giving equal weight to the official price index for MBMW output and an index of average annual earnings of wage workers in Soviet industry.

23. Various Soviet writers have complained of the deadening effect on technological progress of excessive dependence or repairs and maintenance instead

of replacement with new equipment. See for example, L. Gatovskiy, op. cit., p. 6, and S. Kamnitzer, Voprosy ekonomiki, No 8, Aug 1965, p. 10-11.

24. See Kamnitzer, op. cit., for a discussion of the problems of introducing unfamiliar technology. In 1962, more than 80 percent of new workers in the chemical industry had no formal training or had received only short on-the-job training. (G. Zelenko, Pravda, Feb 3, 1964.) One Soviet source estimated that the graduation of chemical specialists had to rise from 10-12 thousand in 1961-62 to 50-60 thousand in 1964-65 to meet the needs of the chemical industry. (Voprosy ekonomiki, No 12, Dec 1963, p. 13.)

25. The Kendall rank correlations coefficients for percentage increases in capital stock and factor productivity for the nine branches of industry are -.25 for 1951-64, -.22 for 1951-58, and -.28 for 1959-64. However, there is about one chance in five that correlations of this magnitude would occur even if the variables were not related.

When, for each branch, five subperiods are ranked by average annual growth in capital stock and factor productivity, there are two positive Kendall rank correlations, two coefficients of zero, and five negative coefficients.

26. The announced index of MBMW output for 1964 is 700 (1950 = 100); the index used in this paper is 485. Yet the index for investment in machinery and equipment in the economy is 478, and this includes net imports which have been sizeable in recent years. Although output of consumer durables has been rising much more rapidly than investment in machinery and equipment, the relatively small weight of consumer durables in total output could not account for the apparently high rates of increase in MBMW production unless military output was also increasing at a high rate.

27. Pravda, Mar 30, 1966, p. 5.

28. Izvestiya, Feb 20, 1966, p. 2.

29. The planned annual increase in labor productivity in industry amounts to 5.9-6.2 percent per year in 1966-70 compared to 4.7 percent in 1961-65 and 6.6 percent in 1956-60.

30. Assuming a weight of .72 for labor and .28 for capital and a $48\frac{1}{2}$ percent increase in industrial output during 1966-70 combined with an average annual increase of $9\frac{1}{2}$ percent in capital stock and 1.9 percent for manhours. The estimate of increase in manhours relies on the announced goals for labor productivity.

31. See source number 7, above.

32. Wageworkers are the rabochiye in Soviet terminology, and the wage and salary workers involved in the production process are industrial-production personnel (promyshlenno-proizvodstvennyy personal). The Soviet statistical category rabochiy is similar to the US category of production worker, although somewhat more limited in coverage. The Soviet category excludes some custodial personnel and technical personnel normally included in the US concept of production worker.

33. For example, some chemicals are produced in the ferrous metals branch, and some machine building enterprises produce ferrous metals. In the output indexes this output appears under chemicals and ferrous metals, respectively, rather than under ferrous metals and machine building.

34. USSR. Central Statistical Administration: Narodnoye khozyaystvo v 1961 godu, Moscow, 1962, p. 182 ; Narodnoye khozyaystvo v 1962 godu, Moscow, 1963, p. 130; Promyshlennost' SSSR, Moscow, 1964, p. 84-85; Narodnoye khozyaystvo v 1959 godu, Moscow, 1960, p. 139; Narodnoye khozyaystvo v 1964 godu, Moscow, 1965, p. 136; (hereafter referred to as Narkhoz 19-- and Promyshlennost' 1964) Murray S. Weitzman and Andrew Elias, The Magnitude and Distribution of Civilian Employment in the USSR: 1928-59, Foreign Manpower Research Office, Bureau of the Census, April 1961, p. 71, 72, and 74.

35. Narkhoz 1958, p. 140, 153-154; Narkhoz 1959, p. 147, 152-154; Narkhoz 1960, p. 226, 231-233; Narkhoz 1961, p. 173, 183-185; Narkhoz 1962, p. 122, p. 132 ~~132~~-134; Promyshlennost' 1964, p. 58-61; Narkhoz 1964, p. 139, 166.

36. Weitzman and Elias, op. cit., Table 5, p. 69 (Reported figure less employment in consumer cooperatives).

37. Unpublished estimate of the Foreign Demographic Analysis Department, Bureau of the Census.

38. Frederick A. Leedy, Producers' Cooperatives in the Soviet Union, Foreign Manpower Research Office, Bureau of the Census, Aug 1958, p. 19

39. Vestnik statistiki, no. 2, 1957, p. 91; Narkhoz 1962, p. 131; Promyshlennost' 1964, p. 87; Narkhoz 1964, p. 138.

40. Narkhoz 1958, p. 665; Narkhoz 1959, p. 596; Narkhoz 1960, p. 645; Narkhoz 1961, p. 602; Narkhoz 1962, p. 488; Narkhoz 1963, p. 506; Narkhoz 1964, p. 590.

41. Vestnik statistiki, No 5, 1961, p. 3-14.

42. U.S.S.R., Central Statistical Administration, SSSR v tsifrakh v 1961 godu, Moscow, 1962, p. 314. (Hereafter referred to as Tsifrakh 19—.)

43. For example, the fixed assets of a wood working ship subordinated to a machine building plant will be included in the fixed assets for "machine building - metalworking," not "wood, woodworking, and paper." In one sense, the fixed assets date are on an industry or branch basis (otraslevyy metod). That is, assets pertaining to subsidiary agricultural production of an industrial enterprise will be classified with agricultural rather than industrial assets, and assets of an industrial enterprise subordinate to construction organizations, collective farms, and the like will be included in the fixed assets of industry. This indicates that the fixed assets of an industrial nature belonging to industrial cooperatives in the years before the industrial cooperatives were transferred into industry were classified with industrial assets. V. A. Goloshchapov, Spravochnik po bukhalterskomu uchetu, Moscow, 1957, p. 74; U.S.S.R., Central Statistical Administration, Promyshlennost' SSSR, Moscow, 1957, p. 5; P. Bunich, Pereotsenka osnovnykh fondov, Moscow, 1959, p. 50-53.

44. Promyshlennost' 1964, p. 68-69; Narkhoz 1961, p. 68; Narkhoz 1963, p. 55; Narkhoz 1964, p. 68.

45. Narkhoz 1958, p. 133.

46. N. M. Osobina, ed, Ocherki po sovremmenoy i zarubezhnoy ekonomike: Vypusk II, Moscow, 1961, p. 54, Vypusk III, Moscow, 1962, p. 110; K. A. Petrosyan, ed, Ispolzovaniye osnovnykh proizvodstvennykh fondov v promyshlennosti SSSR, Moscow, 1962, p. 34, 85, 119, 176, 187.

47. Op. cit.

48. Ibid., p. 73; Narkhoz 1963, p. 127; Narkhoz 1964, p. 142-143.

49. G. A. Burshtein, Osnovnye fondy ugolnoy promyshlennosti, Moscow, 1963, p. 97. Burshtein gives an index for capital stock in 1 July 1955 prices with 1951 as a base. The base is assumed to be (although not so stated) end of 1951 in accord with usual Soviet practice.

50. Narkhoz 1964, p. 68, 142, 516, 523; Narkhoz 1959, p. 67-68; U.S.S.R., Central Statistical Administration, Kapital'noye stroitel'stvo v SSSR, Moscow, 1961, p. 67, 126; Narkhoz 1962, p. 439; Narkhoz 1963, p. 455, 461.

51. Narkhoz 1958, p. 133.

52. Narkhoz 1959, p. 67-68; Narkhoz 1964, p. 68, 142.

53. Ibid.; Promyshlennost' 1964, p. 69.

54. See source 50, above.

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